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Blackings and Coal-Dust

Most technicians during their training learn that spongy platinum is capable of adsorbing an incredible volume of hydrogen, but it is not the only element possessing this property, and a similar characteristic is exhibited by retort carbon. This latter material under reducing conditions also happens to be highly refractory. It is well known that high-grade blackings are often based on retort carbon, and we have been wondering whether its capacity for absorbing gases—or it might even be of adsorbing them—is a factor of practical utility in foundry work, for it is at high temperatures that absorption is effected. It is equally well known that most molten metals evolve large quantities of gas on solidification, and we do not believe for one moment that the film of blacking is sufficient to take care of the amount of gas evolved. But we know little about the selective absorption of gases. That there is a selective absorption at ordinary temperatures we do know. Thus it may be that the action of blacking based on retort carbon is to absorb one or two kinds of gas only. Other materials which suggest themselves as being suitable for the preparation of blackings, such as graphite, plumbago, charcoal and coke dust will certainly possess this property of gas absorption to a greater or less degree, but to the best of our knowledge no fundamental data are available. Hird has demonstrated how coal-dust in use is converted to coke and so sustains permeability in the sands to which it is added, and here again, we suggest that gas absorption properties may be a factor of serious import. The testing of sands has proved to be of the greatest use in the control of foundry practice, but still more work requires to be done at elevated temperatures, using not only air, but gases such as are evolved from various types of metals on solidification. Coal-dust, it was recently suggested, should be relegated to the foundry museum, and no doubt at the back of this statement was the thought that its use created gas. We suggest that there are at the moment insufficient data to permit of judicial deductions being made, because no knowledge is available of the relative absorption power of various sand mixtures at the temperature of casting. It seems germane to emphasise that, from the practical point of view, it is immaterial whether the gases generated in a mould cavity are evacuated by reason of the permeability of the sand mould or by reason of its power of absorbing gases. It would unquestionably be helpful, however, to learn whether the latter factor is of major or minor significance.

Stabilisation

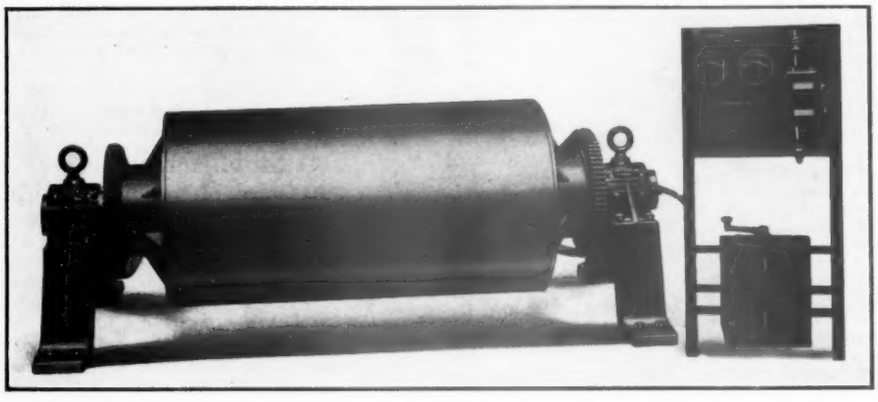
The action of nine of the steel associations within the British Iron and Steel Federation in maintaining and in agreeing to maintain existing prices to the end of 1938 is one of very high importance, and one which is bound to influence other sections of the industry. The associations concerned cover the manufacture of steel generally, including billets and bars, and an essential prior decision of the same kind relating to basic pig-iron had already been taken by the appropriate association. The decision has the approval of the Import Duties Advisory Committee. It has been variously criticised in the Press. Some critics apparently think that such an action will maintain prices in the teeth of a possible slump, but the difficulty which has been encountered in limiting prices is sufficient answer, for all production costs have risen steeply enough to justify a further advance. Furthermore, it has been shown again and again that fixed-price agreements cannot be maintained in a falling market. Hence, we may take it that the scheme is a statesmanlike effort to nip the possibility of boom prices in the bud, and to convert the curve of boom and slump into a reasonably straight line.

Naturally, the matter does not end with the sale of steel. If merchants and builders, for example, are free to charge what prices they like for steel they have contracted to purchase at present prices, the country will be little better off for a self-denying ordinance on the part of steelmakers, but we can rest assured that this and similar points have not been overlooked. Many factors enter into the question of price. Scrap prices, shipment costs for foreign ore and coke prices, for example, affect production costs and are factors over which many steelmakers have little or no control. Much of the recent slump talk is really based on buyers withdrawing from the market on account of rising prices or the fear of still higher prices, and the decision of the associations should go far to reassure the market as to the future. We repeat that stabilised prices must be of value to users. The assurance given will preclude prices from rising, but circumstances may arise of such a character that a lower level is bound to be accorded.

The World's Largest Magnetic Drum

There are comparatively few manufacturers using metals where one or other form of magnetic separator would not prove a sound investment. It is doubtful if the Rapid Magnetting Machine Company, Limited, of Birmingham, when they built their first magnetic separator some 37 years ago, had any conception of the wide field of usefulness such machines and the development therefrom would ultimately serve. The earliest machines were designed for treating swarf, to be followed almost immediately by separators for treating potters' glaze; subsequently machines have been built for treating the widest range of materials for the removal of metals, or the separation thereof, even though the foreign material be of the most feebly magnetic character. A notable development is the cleaning of foundry sands.

There has been no radical departure in principle from the original machine, the modifications having been rather in the refinement of details and modification in design necessary to obtain the highest efficiency for a specified duty. Crushers and grinders and mixers must be protected against damage from tramp iron entering with the feed. For such continuous-running machines two types of separator are available of the self-cleaning type, the most commonly used being the magnetic pulley and the magnetic drum.



LARGE MAGNETIC DRUM BY THE RAPID MAGNETTING MACHINE COMPANY, LIMITED.

On the point of efficiency the magnetic drum is certainly the best choice, in which the feed coming in direct contact with the drum is obviously more thoroughly searched than is possible with the pulley type, with which, of course, the belt is interposed, whilst further, the weight of the drum type is less and the driving power required also less. When, however, the installation is to be made in an existing plant, the required head-room is often a deterring factor to the consideration of a drum-type separator.

Although, given an open choice, the drum is certainly to be preferred, a considerable number of the pulley type are in successful operation. Mention may be made of one built by the Rapid Magnetting Machine Company, Limited, which is handling 200 tons of coal per hr., the pulley in this case being 48 in. dia. by 48 in. wide and weighing rather more than 5 tons.

By the invitation of the directors our representative last Monday saw in the Lombard Street works of the company, what is claimed to be the largest magnetic drum in the world and which is being installed to protect a shredder handling large quantities of sugar cane, against occasional tramp iron entering with the feed. The material is brought forward to the shredder by means of a slat conveyor 6 ft. wide, the maximum depth being 10 in. The separator will be placed below the head pulley of this conveyor.

Constructional Details

The drum is 36 in. dia. by 72 in. wide working face. The centres of the bearings are 8 ft. 10 in. and the overall length nearly 11 ft. The actual weight is 7¼ tons, the switchboard and motor-generator set being separate items. The exceptional depth of feed and the width of the drum have necessitated a special magnet design. The design of a magnetic pulley of large size is a comparatively simple matter. In this case the pole pieces would be securely bolted together, and as the centre of these big pulleys is not used magnetically, the requisite strength can be obtained by the use of a shaft of large diameter.

The construction of a large magnetic drum is a very much more difficult proposition. It is, of course, a first essential that the clearance between the rotating cover of the magnetic poles inside should be cut down so as to ensure the minimum reluctance in the magnetic path; but this introduces difficulties, insomuch as the permissible bending of the magnet unit inside the shell has to be reduced to the absolute minimum. In the equipment under notice the tolerance allowed for bending of the shaft was half a degree per foot length, which is certainly a very small amount.

The main problem in the design of the drum was to produce a magnetic system having a sufficiently high bending moment to prevent any possibility of a sag in the centre being sufficient to cause the magnet poles to foul the cover. The strength of the cover itself is such that no allowance has been made for bending. It was obviously impossible to put a large shaft throughout the drum, because the magnetic permeability of this part would have been much inferior to the rest of the magnet system.

An entirely new method of constructing the magnet system had therefore to be developed, and this is probably unique in that all the parts carrying the magnetic flux are of high-permeability steel. Owing to the limited space inside the drum for the mechanical portion, considerable use has been made of high-tensile bolts and nuts, in some instances very highly stressed; but the design provides for a liberal factor of safety. The bearings are of the double roller self-aligning type, thus providing for misalignment of any accidental stresses put upon them.

The drum is driven by 1-in. pitch duplex roller chains from sprocket wheels provided at both ends of the drum. For the purpose of the demonstration the drive was taken from a countershaft which received its motion by a belt drive from a geared motor of 0.5 h.p., the drum speed being 4.8 r.p.m. The maximum power consumption of the separator is 4¼ kw. The equipment includes a totally-enclosed motor-

(*Concluded in next column.*)

(*Concluded from previous column.*)

generator set, as magnets of this type require direct current.

The switchboard comprises a star-delta starter for the motor-generator set, ammeter, voltmeter and shunt regulator for the direct-current side and a potentiometer controller and resistance for dealing with the magnet current in order to avoid breaking the circuit, which would lead to a dangerously high induced voltage liable to damage the insulation. The first operation of the controller is to connect the potentiometer resistance across the line; further movements of the controller place one end of the magnet winding to different tappings on the resistance until the last stage is reached, and the magnet is connected direct across the line with the potentiometer resistance cut out.

To switch off, the reverse procedure is carried out. At the last stop the magnet leads are short-circuited on themselves. At no position is the circuit open.

Random Shots

In these days of boom and rush in the business world it is refreshing to find someone who can steal sufficient precious leisure moments to write a book which has nothing whatsoever to do with his business. Mr. Sidney Rogerson, who is publicity manager of Imperial Chemical Industries, is shortly to publish a War memoir called "Last of the Ebb." It deals with the last German break-through in Champagne in March, 1918. The book should be of special interest, because the story will be told from both points of view, Mr. Rogerson having worked with the co-operation of General Von Uritch, who planned the German attack.

* * *

At the annual dinner of the London Iron and Steel Exchange recently, one of the speakers told a story, which, though not exactly "still wet from the printer's," is definitely in the category of the story that will bear any amount of repetition. A boy, brought before the magistrate, was asked in what trade his parents were engaged. The reply came readily: "In the iron and steel trade. Muvver does the ironing and Farver does the stealing."

* * *

Most people would hesitate to go so far as John Wilkinson, who cast his own iron coffin in anticipation of the need for a final resting place for his mortal bones. But any reader whose sense of the appropriate is so keen as to be likely to follow him to the grave, might make a note of the following epitaph. It is inscribed on a tablet in the church of Saint Mary, Bury St. Edmunds, is dedicated to an editor, and reads as follows:—

Like a worn-out Type
He is returned to the Founder,
In the hope of being recast in a better and more perfect Mould.

* * *

For sixpennyworth of incredibility a visit to the crypt of St. Paul's Cathedral is recommended. Here is stored the funeral car which bore the coffin of the Duke of Wellington through the streets of London exactly 85 years ago. It is a massive affair, nearly 6 ft. high and 10 ft. long, built up of an agglomeration of intricate castings—even the wheels—made from remelted cannon. It weighs 18 tons, and was used on the 18th day of November, 1852. The "legend" goes on to say it was completed in 18 days! It certainly looks as if that were a sort of abracadabra number, for such an extraordinary piece of work to be turned out of any foundry, especially in 1852 when foundries were not mechanised, savours rather of a tale from the Arabian Nights.

"MARKSMAN."

Trends of Continental Steelfoundry Practice

By P. C. FASSOTTE (Brussels)

This Paper, read before the London Branch of the Institute of British Foundrymen, Dr. A. B. Everest presiding, forms one of the Overseas Guest Series. Previous lecturers to the Branch have included Mr. E. Ronceray (France), Dr. Werner (Germany), Dr. Vanzetti (Italy) and Mr. Russell (Australia).

This Paper is not a thesis, but rather an attempt to give a broad idea of opinions and general tendencies prevailing amongst the steelfounders on the Continent, and of the directions in which they are striving to solve the ever-present problems of great efficiency and better products. Its only ambition is that it aims at being objective, although it is not easy, with such a subject, to avoid altogether subjective interpretations. A French critic said of a novel that it is "a piece of life seen through a temperament." An endeavour, however, will be made briefly to describe the trend of things on the Continent without allowing personal opinions to intrude.

Two Main Groups

If orderly minds, possessing the habit of classification, analyse the working conditions of Continental steelfoundries, they will be strongly tempted to divide them into two main groups. They will find in Belgium and large parts of France an important body of steelfoundries, quite a number of which produce tonnages upwards of 1,000 tons a month, and some exceeding 2,000 tons, who rely solely on natural moulding sands as a moulding medium. On the very doorstep of these foundries, or within a cheap rail freightage, exist deposits of sand peculiarly suited to the steelfoundry and, quite logically, the foundries in these districts have concentrated on the use of this material. They have done so to the exclusion of any other. In the whole of Belgium and Northern France, "compo." is unknown in the steelfoundries, and it is not even used for castings upwards of 50 tons.

Influence of Local Conditions

Having once started with the local raw material, they soon perceived that its quality enabled them to develop a practice of casting steel in green-sand moulds, and to their credit it may be said that they have exploited this possibility in a full measure. In this group, there are to-day steelfoundries using the green-sand process exclusively, others where dry-sand moulding is practised can be considered as exceptional.

Fully to develop the possibilities of their green-sand practice, these foundries were naturally attracted by the use of the small acid converter, with its concomitant of quickly repeated heats, small ladles, lip pouring and shanking. They were fairly well situated for obtaining raw materials for their converter plants, the freights on hematite from the North-East Coast being reasonable and the Customs duties, at any rate in Belgium, quite nominal. The Franco-Belgian group of steelfounders may therefore be broadly characterised by its use of sand as a moulding material, the development of an extensive green-sand practice and the intensive use of the acid converter.

German Practice

The opposite school was developed in Germany. The moulding sands available were not of the same high standard, and the quarries were mostly situated a long distance from the metallurgical centres. Reliance, therefore, had to be placed on synthetic materials, and in the preparation and use of moulding compositions, the German foundries have achieved a remarkable measure of success. With characteristic thoroughness they set themselves the task of producing from chamotte—by calcining it at high temperature, crushing and grading it—an exceedingly fine base for a moulding composition. The material has a high refractoriness and the care lavished on its manufacture ensures that high standard of *regularity* which is perhaps the foremost quality of any moulding medium.

The bonding clays used impart generally to this chamotte composition a greater strength than is found in similar materials used in Great Britain, the speed of moulding being thereby accelerated and the need of mould repairs reduced. Similar care has been devoted to the production of mould washes, with the result that some German foundries are producing castings of startling cleanliness with the use of composition. Green-sand moulding in this material is, however, not practical. Another factor gives the German foundries a different aspect from the Franco-Belgian. In Germany converters are somewhat handicapped, particularly so since the war. Probably the main reason is the difficulty of procuring hematite of the right type. Whereas the English steelfoundries can in normal times obtain hematite with a maximum phosphorus as low as 0.02 and, on an average, 0.03 per cent., the German steelfounder cannot obtain at a reasonable figure a hematite with less phosphorus than 0.08 per cent. Everything favoured, therefore, the basic open-hearth furnace, and later the introduction and development of electric furnaces.

The German foundries can be considered as typified by the use of basic steel, synthetic moulding materials and dry-sand practice. Other countries in Europe followed either one or the other of the two main tendencies, according to their local conditions and the respective facilities for obtaining one or the other set of raw materials at an economic figure.

Diffusion of Practice

However, this broad division of Continental steelfoundries into two groups must not be considered as absolute. The two schools have reacted on each other, or rather there has been a phenomenon of osmose, of interpenetration between the two practices. Whilst in Belgium and Northern France sand is still being used to the exclusion of "compo," even for the heaviest castings, in Central France, Switzerland, Holland and other countries, synthetic preparations are used to a fair extent. In Germany the movement has been in the other direction, namely moulding sand has found its way into most foundries, at any rate for the production of the lighter work. One foundry produces all castings with wall thicknesses of $\frac{3}{8}$ in. in sand; another limits the use of sand to castings below three tons in weight, but all German informants agree that the progressive use of natural sands is a feature of recent steelfoundry practice in Germany.

Phosphorus Control by Mixed Process Installation

Inside the Franco-Belgian group another tendency, not less noteworthy, has made itself felt. The typical Franco-Belgian foundries of a few years ago were equipped with converters. Some of the large foundries had also one or more basic open-hearth furnaces of relatively small capacity, usually between 8 and 15 tons. This combination of converters and small basic open-hearth furnaces was always considered as a fortunate one, as by judicious transfer of scrap produced by the two processes, the tendency for the average phosphorus to rise was held in check, and the supply of suitable scrap for the converter thereby facilitated. The converter remained the backbone of the steel supply, however, and the whole trend of thought was directed towards exploiting to the full the elasticity of the converter process, its ability to cope with varying quantitative needs, and the peculiar suitability of its steel to the requirements of a green-sand floor. With those considerations uppermost in their minds, and looking on the converter essentially as a tool for intensive production, the Franco-Belgian steelfoundries on the whole have somewhat neglected the other possibilities of the acid converter.

Slow Development of Soda-Ash Process

For instance, as a body, they have definitely been slower than their British colleagues in standardising the soda-ash process, which has done so much to rehabilitate the acid converter. Many of them have not credited the converter with being able to cope, at any rate to some extent, with the new requirements of the customer in alloy steels. For instance, there is no parallel on the Continent for that important British steelfoundry which is producing, with converters only, the largest proportion of its castings in alloy steels (of the manganese-carbon, chromium-carbon, and nickel-chromium varieties).

It is somewhat curious to reflect that, whereas it could be said that the acid converter has its natural home in Belgium and Northern France, to-day the possibilities of the converter seem more highly esteemed in Great Britain than anywhere else. It is in Britain that are found to-day some of the most confirmed protagonists of the converter, and also some of the most able exponents of its practice.

Electric Furnaces and Alloy Production

When, during the last ten years, a growing demand arose for alloy steel castings, the electric furnace received a sudden impetus in Belgium and France. In Germany most foundries were already relying on the basic arc furnace, and the same still applies to Italy and Switzerland. In the Franco-Belgian group there have been numerous instances, particularly during the last five years, of the installation of basic arc furnaces. The induction furnace also made its appearance, and quite a number of foundries in every country have now installed them. It is considered by some as the furnace of the future for the steelfoundry. Some of these installations are quite large; one which was visited recently has four furnaces, another has three—a 5-cwt., a 10-cwt. and a 15-cwt. unit; and a third has two 10-cwt. and one 3-ton units.

New Induction Furnace Practice

While on the subject of induction furnaces, it is interesting to note that efforts to develop a refining process have met with a very fair measure of success. Crucibles are lined to-day with a basic refractory, twenty-five to thirty heats per lining being common practice. Thin basic slags are produced, particles of which are actually drawn into the metal itself by the vortex caused by the eddy currents. The calorific input is increased to the maximum during the refining. These slags are easily removed, and, if necessary, renewed. Their momentary partial immersion in the steel is said to be without effect on the cleanliness of the metal. It is further said that phosphorus has been removed with three consecutive slags to the extent of leaving only a remnant of 0.005 per cent., but no figures for extra current consumption were available.

Unusual Duplexing Practice

Another somewhat exceptional practice in relation to arc furnaces may also be of passing interest. A Continental foundry is using a basic

electric furnace for producing its steel, but transfers a part of the metal to a small acid electric, and works it again with an acid finishing slag. They resort to this costly operation with the sole view of imparting to the metal the better life associated with acid steel. The object in this case is to produce more easily small steel castings in green sand. It was, at the time, the only instance of this peculiar duplex process which had ever been brought to the author's notice. On further inquiries it was found that not only basic electric, but also cheaper basic open-hearth steel is transferred in Germany to either an acid arc furnace or an acid induction furnace for the same purpose, and that this duplexing is a fairly regular practice.

Outlets for Alloy Steel Castings

To-day the basic arc furnace and the induction furnace are producing the large majority of alloy steel castings on the Continent. One should mention, however, that for the 12 per cent. manganese steel castings, many foundries rely on the converter, though others have a distinct preference for the arc furnace. The increase in use of alloy steel castings has been exceedingly rapid. For instance, a foundry of world reputation, catering exclusively for outside customers, is turning out now an average of 30 per cent. of its production in alloy steel. Drawing offices in engineering works seem to have become conscious of the higher demands which can be made upon alloy castings. Specifications containing nickel, chromium and molybdenum, which ten years ago were an exception, are now regularly received, and steam-turbine castings, for instance, are frequently ordered in 2 or 3 per cent. nickel steel.

The chemical, cellulose, artificial-silk, brewing and other industries have developed a very strong demand for non-corrosive steels. The foundries which have been preparing themselves to meet this new demand are quite numerous. Alloy castings with 25 per cent. of nickel and even more are being produced as a matter of routine. Alloy steel castings are being ordered on repetition lines. An order recently received by one foundry was for 400 sets of small castings in 18 : 8 steel, weighing a total of 8 tons. The average weight was no more than 9 lbs. The castings are intended for dairy plants and some of them are likely to tax the ability of the supplier to the utmost. High-chromium steel castings are ordered for wearing purposes, particularly for working in high temperatures. The low-chromium steels or manganese-chromium steels are demanded for a variety of purposes, amongst others for connecting rods and crankshafts for large internal-combustion engines and compressors. Where high physical tests are required, and particularly shock-resisting tests, the steelfounder offers a large choice of materials in the nickel-chromium range. Molybdenum steels for high-pressure steam ducts, austenitic steels for the chemical and other industries, and chromium-tungsten steels which retain strength at high temperatures together with wearing qualities—all these the steelfounder supplies now in ever increasing quantities.

Certain sources of work for the steelfoundries have dried up. In Belgium, for instance, welded constructions have ousted high permeability steel castings almost entirely, although this is not the case in Germany. New fields, however, have been tapped; as an instance, underframes for tenders and carriages cast complete with axle, box guides and accessories, which a number of railways have standardised. Previously, these parts were constructed or welded. The problem of making these underframes has entailed a good deal of research and large outlays on equipment, yet a fair number of foundries are to-day in a position to supply them, and deliver them in the finished machined state.

Laboratory Facilities

All these specialised requirements have considerably altered the conditions of technical management. In the days when straight carbon steels only were produced, the laboratory played a very minor role, and sometimes was non-existent. To-day the highly-trained metallurgist has come to the fore. In fact, he has become inevitable. His staff has been increased, and his equipment brought into line with the accrued importance of his work. Some steelfoundry laboratories which have been visited in recent months can be said to be equal in every respect to the best encountered in the heavy steel industry. Research work has become a feature of these laboratories. Customers call in the steelfoundry metallurgist to help to solve their own special problems. Whereas, in the past, the the laboratories were used merely as a check on products and raw materials, to-day the problems of non-metallic inclusions, grain size, heat-treatment, wear, corrosion, and strength at high temperatures have become as familiar to some steelfoundry staffs as to the makers of alloy steels in rolled and forged conditions.

What is true for the laboratory is equally so for the heat-treatment shop. The old grate-fired annealing stove has given way to modern furnaces with equilibrated temperatures capable of reaching and maintaining any temperature up to 1,150 deg. C. Quenching tanks with coolers and dipping tackle have been installed, equal to those found in forges and stamping shops. The growing importance of the scientific side of management, both as regards personnel and plants, is one of the outstanding developments which have taken place in the steelfoundries.

Acceptance Tests

A subject connected with the laboratory work is that of physical tests. It is not surprising, since the same tendency prevails everywhere, that physical tests have become more stringent, and that private customers more and more insist on test-pieces being attached to the castings. Physical tests have been required for many years by the national buying authorities, such as the Admiralty, War Office, mercantile marine, railways, etc. To-day a large number of private engineering works are in turn requiring tests for the castings they buy. The more noteworthy development has been that of the shock tests of the Izod, Charpy and Mesnager types. New types of test-pieces have been introduced recently, but discussion is still raging in every country as to the best type of test-piece for shock purposes.

What is striking is the increased number of specifications calling for a shock test. It has led the foundries to overhaul not only their steelmaking, but to give more attention to the question of heat-treatment. Some daring practices have been evolved, such as that of a particular foundry which does not hesitate to water-quench all castings subject to shock tests provided the carbon remains in the neighbourhood of 0.2 per cent.

The yield-point is stressed by customers far more than the ultimate strength, particularly in Germany. It is now well known that a high yield-point at elevated temperatures is favoured by a molybdenum addition, and molybdenum steel is specified for all castings for high-pressure steam, certain castings for the chemical industry, etc. These castings are regularly tested for their resistance to creep, the usual test prescribed being from 25 to 35 hours and the limit of creep accepted 5/10,000 of the test-piece per hour.

X-Ray Testing

The other move which is definitely interesting is the attention being paid to X-ray testing. It is felt by many foundries on the Continent that, whether they like it or not, the time is near when they will have to agree to X-ray testing. A move has been made in that direction by some of the defence ministries. Light-alloy castings for aircraft have been subjected to X-ray testing as a routine test for some considerable time, but in certain countries this has been extended to all steel castings entering into the manufacture of aircraft or aircraft engines. The X-ray test has also been imposed definitely for a number of castings supplied to admiralties.

The view has been repeatedly expressed by foundrymen that the X-ray test is bound to become more and more in request, and it must be admitted that the very nature of a steel casting gives a peculiar importance to this test.

Curiously enough, most foundries look upon this development with a good deal of equanimity. They are of the opinion that, however troublesome it may be to have to undergo an extra test, and one capable of revealing hidden defects, this test will bring to their notice deficiencies in their practice and will therefore prove helpful in the long run. The more progressive consider that they should forestall the imposition of the test and themselves use the X-ray apparatus as an instrument for routine control. They hold the view that it is up to them, as steelfounders, to deliver as perfect a product as possible, and that any test capable of showing up hitherto unknown defects is likely finally to help the industry.

They point out that in the manufacture of welded articles it has already become a practice to supply, when required, a complete photograph of every weld in a job, and that nothing done by the welding industry has done more to create confidence among the buyers than the development of this practice. The objection of the steelfounder, therefore, is not one of principle. What is feared is the fact that, the time taken for testing with the present X-ray apparatus being lengthy, if the test is applied to a large number of castings, both space and time will be taken up, which will constitute an impediment to production. The maximum capacity of X-ray apparatus that seems practical in a foundry is either of 200 or 300 kilovolt capacity. Beyond this figure manufacturers hesitate to go, as the plant might become dangerous in inexperienced hands. If, with plants of this capacity, it were possible to obtain pictures by direct illumination, say through a section of a few inches of steel, the plant would undoubtedly receive a very much wider application for routine tests than is the case. Sections up to 4 in. can be examined by the X-ray apparatus, but only by means of a photographic plate, and the process lasts for hours.

In spite of this limitation, it is felt that the X-ray plant, owing to its ability to reveal defects or weaknesses which could not be discovered by any other means than destruction, is bound to play an increasingly important part in the acceptance of steel castings. Several foundries on the Continent are already equipped with X-ray apparatus at the present moment. Over a dozen of X-ray apparatus are functioning, on the other hand, in light-alloy and other foundries.

Sand Preparation and Handling

In the moulding shops there have been no developments of very striking importance, except, perhaps, the general tendency of improving the sand-preparation plants, and to solve at the same time the problems of transport connected with sand. In many foundries, due to the lay-out of the shop, the cost of handling the sand from the knocking-out place back to the moulding floor, after having passed through the sand preparation, is a definitely more costly operation than the actual preparation of the sand. Comprehensive sand preparation and transport plants have been built or are contemplated everywhere.

The sandslinger has made far less progress in the steelfoundries than in the ironfoundries. For some unexplained reasons, this machine is not made such extensive use of in the Continental foundries as in those of Great Britain.

Moulding Machines

With regard to moulding machines, the Franco-Belgian founder has definitely very little use for the turnover machine; he prefers a straight-jar and lift or pressure machine, which with his strongly-bonded sands are quite satisfactory. With "compo" or the leaner sands used by the German founder, this is not the case and a preference for the turnover machine is almost general throughout the German foundries. Oil sands are used

on the whole very sparingly, and only for castings of thin sections and complicated design. Often, however, outside cores in oil sand are fitted into "compo" moulds to facilitate contraction and to avoid hot tears. Composite moulds made partly of "compo" and partly of moulding sand are also resorted to in many instances.

Fettling-Shop Developments

In the fettling-shop, the bakelite-type grinding wheel driven at constant peripheral speed has become fairly general. The shot-slinging type of cleaning plant has made its appearance in many foundries and is watched with interest by the whole of the foundry community. The fact that a certain amount of competition has appeared between makers is considered as likely to prove helpful to popularise this method of cleaning. On the other hand, cleaning steel castings by means of a high-pressure water jet seems to have caused disappointment. With the pressure of 50 atmospheres used in this machine, the power consumption is appreciable. Special problems arise connected with water supply and disposal of sludge, but most of the criticism is directed to the fact that the efficiency of the machine drops considerably when core irons or core supports are met by the stream of water. It is generally felt that this machine may prove of greater boon to the ironfounder than to the steelfounder.

Riser Removal

An increasing use is being made of machines for removing, with an oxygen burner, risers the base of which is in the shape of a segment. Special machinery has been put on the market for this purpose, whereby the burner is automatically guided along a given radius. More noteworthy is the increasing use of power-driven machines carrying inserted teeth. Machines are nowadays used by the steelfoundries the general design of which reminds one of a horizontal borer, but with a massive head-stock of square section, at the end of which is provided a saw with universal movements. In one foundry eight of these machines are standing in a row and are used for cutting off any type of riser having a flat base. One of the machines in this row has a cutting capacity of 13 in., and when inspected was actually removing a circular head with a section of approximately 20 in. The operation was naturally made in four cuts. This machine is particularly valuable when castings have to be supplied with a rough-machined base. It would appear that, from the point of view of cost, it has its advantages, since the particular foundry has almost done away with the oxygen burner for removing heads. They claim that this type of saw is a cheaper proposition provided a number of saws can be looked after by a single operator.

The author hopes that this brief survey has left the impression which was intended to be conveyed, namely, that the Continental foundries are also alive to the need of moving with the requirements of the time. An industry is a live body, not a static institution. The steelfoundry industry is moving fast and tries hard to do its share in the general progress of engineering.

Employer-Federation Activities

With association and price-fixing problems still looming in the minds of steel-castings manufacturers, it may be interesting to know in what way Continental countries have been meeting the emergency which arose during the last depression, when selling prices went below production costs. In Spain, prior to the tragic events of the last fifteen months, an association of steelfoundries functioned for a few years. The basis of the understanding was not one of tonnage quota, but merely an undertaking to quote minimum prices for all classes of work. A number of members of this association expressed themselves fully satisfied with its method of operation and no discordant voice was heard.

In France the Syndicat Général des Fondeurs, which groups the foundries of all metals, was formed as far back as 1920. It is more concerned with establishing standardised selling conditions regarding estimating costs, packing, transport guarantees, patterns, replacements and payment conditions than with fixing new prices. In Belgium a timid attempt has been made towards the establishment of a price policy, but only as far as the home railways are concerned. Such an association existed already before the War, was revived after the War, and, later on, dropped. About a year ago, this association with limited scope was brought to life once more. Thirteen main foundries belong to it. The method of division of the work is somewhat involved; it takes into account both selling price and tonnage, as some castings are worth considerably more per ton than others. There seems little likelihood of the understanding being extended to general work.

In Germany there was created, five years ago, an organisation in many respects similar to the British association called the Verein Deutscher Stahlformgiessereien, with its head office in Düsseldorf. The various classes of castings are carefully tabulated, and the German counterpart of what some British steelfounders call their "Bible" contains 101 pages starting with "Abdechplatten" and finishing with "Zylinder Verbindungen für Lokomotieven." A carefully compiled index refers to minimum prices which must not be underquoted. Categories of prices are mentioned according to weight. Penalties are foreseen if the minimum prices are not respected, but foundries are at liberty to quote higher figures. No arrangement exists regarding a division of tonnage on a quota basis, but it is interesting to note that the price arrangement applies equally to straight carbon steel and alloy steels. Percentage increases are naturally foreseen for the latter. For certain specialities, however, mostly to be delivered in sets like Pilger rolls or locomotive parts, there are separate understandings.

The various firms having received the inquiry, send their estimated figures to the association office in Düsseldorf, and after an examination of the estimates, it is the association which decides which price has to be quoted. Only then is a final price submitted to the customer.

Another association is functioning in Germany, namely the Stahlräder Verband. It is composed of eight or ten of the principal steelfoundries of the Reich, and is dealing with the sale of wheel centres, mine-tub wheels, and complete wheels and axles. The members of this association each have a right to a given percentage of the tonnage available. The invoices are actually sent to the association itself, which in turn invoices up to the customers, receives the product of the sale and pays the supplier. Both these associations seem to work to the entire satisfaction of the members. They have introduced orderliness in the market, and the customers themselves appear to have accepted the position ungrudgingly.

Acknowledgments

The author wishes to express his sincere thanks to all the Continental steelfounders who, during the past few months, by the frank discussion of their problems and their readiness to give information, have made it possible to give this, at any rate, true picture. In this connection mention must be made of Mr. Buerger, of Schaffhausen; Mr. Schweizer, of Saarbruchen; Mr. Jacques Henricot; Mr. Michaux, of Peugeot, and especially of Dr. Resow, of Krupps. The others are too numerous to mention, but to all of them is due the author's personal appreciation of their help.

Copper in Cast and Malleable Iron

A printer's error last week caused Mr. W. B. Sallitt, author of the above Paper, to say near the end of the second column of page 380 that "copper, by its graphitising action, removed chill from, and *never* (instead of *hence*) softened, thin sections."

The Slump in Copper

By "Onlooker."

Looking back but little more than six months, it seems hardly credible that standard copper on the London market was then well over £70, while electro has topped £80 with the American domestic quotation at 17 cents. True, it only stayed at these exalted levels for a matter of days, almost of hours only, but dizzy heights were reached even though very little business was put through with consumers at the time. What a change has occurred! Since the turn of the tide in early March the trend has been almost persistently downwards, apart from a brief rally at the beginning of August, and now standard has fallen below £40. In the States the price is 11 cents domestic, but with sales running at barely 5,000 tons per week, a further reduction seems certain, and there are those who feel that American users will not be encouraged to buy in anything like quantity until the quotation breaks 11 cents. The export price is, of course, well below 11 cents now, and the American consumers feel that they are being asked to pay too large a premium over the world price, but in voicing this complaint they seem to forget the 4 cent duty on foreign copper entering the United States.

Over this matter of the everlasting crumbling of the copper price London blames New York and New York blames London. Undoubtedly there has been heavy bear selling in Whittington Avenue, but since this was encouraged largely by the weakness of the American stock markets, it looks as if the blame can be fairly apportioned between the two centres. The "vicious circle" has certainly played its full part in depressing values during the present year, and the extent to which Whittington Avenue has been dominated by New York is really remarkable. Up to 1929 America was the greatest force in copper, and costs of production there really determined the world price; but with the entry into production on a large scale of the Chilean and Canadian companies on one hand and the African mines on the other, a far-reaching change has taken place in the outlook. Very large quantities of copper are now produced at around 6 cents or lower, so that standard copper at £40 is not by any means a bad proposition for the producers. From the profits earned by the mining companies in recent months one can form some idea of what margin exists when the price is over £60, but it is also certain that at these high levels copper has many rivals. Modern practice in mining and refining has made it possible to market copper at a really reasonable price, and it ought therefore to figure among the low cost commodities.

From the foregoing it will appear that there is no reason why copper should stand at anything but an entirely reasonable level, and it has been evident for a long time that the increase in value in the early months of this year was entirely unjustified. In plain language, consumers suffered from a price ramp of the first magnitude, and the extent of the present slump is directly attributable to the violence of the upward movement in the spring. One extreme leads to another, and we are now paying for earlier stupidities in the shape of a prolonged downward sweep which will certainly carry the quotation down too far. When the turn will come it is impossible to say, but in the opinion of the writer it is not in sight yet, and if the pendulum is fated to swing too far then it may be well under £40.

Pig-iron Loyalty Rebate Scheme

We regret that the second sentence of our leader last week on the above subject contained an error, to which several readers have drawn our attention. The sentence should have read: "This definition states that the foundry and forge pig-iron referred to in the document contains *not* less than 0.75 per cent. of phosphorus." The word "not" was inadvertently omitted.

Foundry Costing

DISCUSSION IN BIRMINGHAM

Members of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, and members of the Midland Section of The Institute of Vitreous Enamellers, met at the James Watt Memorial Institute, Birmingham, on November 5, to discuss the Report of the Costing Sub-Committee of the Institute of British Foundrymen. The Report* was presented by Mr. V. Delport (Convener), and the chair was taken by Mr. H. J. Roe (Branch-President), who said that the information had been collected from sources throughout the country and collated by Mr. Delport.

A Measure of Efficiency

MR. J. A. LACEY opened the discussion by proposing a vote of thanks to Mr. Delport. In doing so he admitted that the Report had helped him to consolidate some of his own ideas. The Report was worthy of a great deal of attention by everybody engaged in the foundry industry. It must be remembered that a costing system, if it was to be of any use at all, must mirror the activities of the foundry in detail and as a whole. Costs represented the measure of efficiency of a foundry's activities, being used not only for the determination of price, but to indicate any leakages of profit that occurred within the foundry.

He was whole-heartedly in accord with the suggestion that the foundry should be sub-divided into groups of products. Indeed, he would say it would often be desirable to set up profit and loss accounts for the various sections within a foundry. It was of incalculable benefit not only to sub-divide the work within a foundry, but to be able to maintain a true picture of the efficiency of each section. He suggested that efforts should be made to get away from the term "costing system." The system of conducting a foundry, if wisely inaugurated, would contribute to the compilation of costs within that foundry. They should not have the patternshop mixed up with the foundry, as a foundry. If it was regarded as a separate department, having its own profit and loss account, then its products could be divided into two groups: for capitalisation and for maintenance or overhead charges. There might also be a third group which might be regarded as a sale, or a direct charge to the customer, but he did not think such a cost should be mixed up with the cost of the foundry product. It should be an extra charge and not become part of the cost of the casting.

Mr. Lacey stated that maintenance charges came under overheads, and should also be regarded as service charges. It was essential that service charges should be so recorded on the timesheets that the charges could be made direct to the particular department calling upon the services of the various men. He wanted to issue a word of warning in regard to depreciation of melting plant and local taxation. The report referred to "local taxation in proportion to the floor space occupied." Local taxation might be assessed on the size of the building, and then one might be led astray on the question of floor space. He was not criticising the Report, but offering suggestions for its extension.

The Problem of Overhead Charges

To those who had control of foundry organisation the question of overheads was a serious matter. If, in a profit and loss account, they considered all charges except those for direct materials and direct labour as overheads, they would find overheads becoming an appreciable portion of the costs. They must not be led into the error that overheads represented a kind of sump for charges that could not be regarded as direct or indirect charges and were consequently lumped together as overheads. There was a tendency to-day to put everything into overhead charges. While the scheme had been put forward as a sound scheme, it was important that the question of the fluctuating load in the foundry should not be overlooked. The question of overhead charges would have to be given serious consideration when dealing with a matter of that sort. There was no suggestion in regard to such fluctuation in the Report, and if the Sub-Committee were considering the question of an addendum, that was one of the items that should be considered. He favoured the absorption of overheads on the basis of direct labour.

Mention was made in the Report of moulding boxes and tackle. In many foundries one would be appalled by the amount of space occupied by idle moulding boxes and tackle, and he thought the Sub-Committee might also suggest that foundries should not accumulate those things which could be turned into good castings. He also strongly urged that overheads should include an item for errors and defects. Further, a great deal of expenditure was often entailed, long before an order was received, in estimating and designing. Then there were directors' fees and probably one or two other charges which might be regarded as cumulative and could only be added at the finish of the costing of a casting. If the additions he had mentioned were used as an addendum, he thought they would round off the Report to finality.

In seconding the vote of thanks, MR. G. W. BROWN emphasised that, following the issue of the Report, the question of costs was really in their own hands. If they, as executives, insisted upon having costs, then he felt sure that the management and directors would endeavour to find ways and means to give them those costs. Unless, however, they insisted, the question of general foundry costs would never make much headway, because only foundry executives were in a position to know and to detail exactly what costs they wanted and how they were to be achieved. He was confident that the results of the Sub-Committee's labours meant a new era in foundry organisation and administration. Every credit was due to the Sub-Committee and especially to Mr. Delport for the able way in which they had put their conclusions before the members.

Mr. Delport's Reply

Replying to the questions raised by Mr. Lacey, MR. DELPORT said the Report implied that the cost of a pattern specially made for a given job should be added as a separate item to the cost of the casting. As regarded other patterns, they should be capitalised and the cost treated as a sort of overhead charge on the foundry. The question of local taxation depended, of course, upon the practice of local authorities. He wondered whether the question of the different foundry loads came within the terms of reference of the Sub-Committee, and did not know whether the Sub-Committee could make any recommendation in regard to it. They had had the question of defective castings in mind, but had not made any recommendation. The cost of preliminary work and designing should be taken into account. When an order was obtained such preliminary work, he took it, was charged to that order. The Sub-Committee's intention was that the Report should be studied by the industry, and perhaps later on they might bring it out again with certain modifications and in a more complete form than it was at present.

The CHAIRMAN (Mr. H. J. Roe) suggested that if Mr. Lacey would furnish details of the points he had raised, the Sub-Committee might be able to make use of them in a way which would be for the benefit of the industry at large.

The question of machining costs was raised by MR. HANMER, and in reply MR. DELPORT pointed out that the Sub-Committee had not dealt with them, having stopped at the time the casting left the fettling shop. If they dealt with machining costs, there was no reason why they should not deal with enamelling and the like.

Replying to further questions the CHAIRMAN, on behalf of Mr. Delport, said he thought that detailed records of gates, runners, etc., should be kept, but it was not intended that these should be collected each day. In regard to chaplets and sprigs he admitted it was difficult to allocate a direct charge for these. The idea of the Sub-Committee was to make a direct charge to the job whenever that was possible. The division of direct labour was one of the points on which each individual foundry would have to use its discretion. Similarly, discretion would have to be used in regard to drying stove charges.

MR. DELPORT pointed out that when the word "job" was used in the Report each individual casting was not meant, but either one big casting or a set of smaller castings.

* FOUNDRY TRADE JOURNAL, June 10 and 17, 1937.

Notes from the Branches

Sheffield Branch.—A short Paper competition, for which two prizes were offered by the Branch-President (Mr. J. B. Allan), was held by the Sheffield and District Branch of the Institute of British Foundrymen on November 4. Four Papers were submitted, and were read to the audience by members of the Branch Council, the authors' names not being disclosed until after the general body of members had voted by ballot.

As a result of the ballot the first prize was awarded Mr. W. H. Salmon, for a Paper on "Scrap Grinding Wheels Used as Foundry Refractories." The second award was to Mr. J. H. Pearce for a Paper on "This Fluidity." The other entries were by Mr. H. S. W. Brittain ("Old and New Patterns and Patternmaking") and Mr. R. D. Howe ("Loam Patterns and Cores").

Two further non-competitive Papers were read. One, by Mr. T. R. Walker, was entitled "The Classification of Foundry Sands," and the other, by Mr. J. Roxburgh, dealt with foundry management. A vote of thanks to the authors of the six Papers was accorded, on the proposition of MR. M. BROWN.

Prof. J. H. Andrew presided over the meeting, in the absence of the President.

Pig-Iron and Steel Output

There were 133 furnaces in blast in the United Kingdom at the end of October, compared with 132 furnaces at the end of September, four furnaces having been blown in during the month and three having ceased operations. The production of pig-iron in October amounted to 769,600 tons, compared with 726,600 tons in September, and 670,300 tons in October, 1936: it is the highest output recorded since the war. The month's production included 169,500 tons of hematite, 421,400 tons of basic, 142,900 tons of foundry and 20,900 tons of forge pig-iron. The production of steel ingots and castings in October amounted to 1,133,600 tons, compared with 1,163,000 tons in September and 1,060,500 tons in October, 1936. The slight recession in the month's figure for steel ingots and castings is largely explained by the fact that October contained five Saturdays and five Sundays, on which days a number of shifts are normally lost.

Patternmaking for Production Moulding*

By S. A. HORTON

This Paper is one of a series dealing with the various sections of foundry practice, and it is proposed to deal with several general principles that deserve consideration and are essential to the craft of patternmaking, particularly when the patterns are being constructed for production moulding.

The author has purposely selected patternmaking for production moulding, because he is of the opinion that this type of patternmaking is of more general interest, but pattern equipment for one-off or small production castings must not be disparaged. The construction of some of these patterns requires a considerable amount of skill, whilst others are more or less pattern joinery which leave much to the imagination and skill of the moulder.

It would be ridiculous to attempt to state any hard and fast rules regarding the design or construction of any kind of pattern equipment to be used in foundries generally. Each individual foundry is designed for, and has installed, different equipment, *i.e.*, moulding machines, moulding boxes, core ovens and labour; therefore, each suggested design for a casting is a different problem for each individual foundry. A pattern equipment which is very satisfactory in one foundry might possibly be unsuitable in another. It would not be true to say there is only one correct pattern equipment for any selected design of casting; one particular casting could be produced by twelve foundries, and each pattern equipment could be slightly different, yet each of these foundries could be producing this casting by the most economical method applicable to its condition of casting production.

Design of Pattern Equipment

The pattern is really a moulding tool, and when equipment to produce a new design of casting is under consideration the foundry should be consulted. If the following method of procedure was general practice the design of all pattern equipment would necessitate a working relationship between the two departments, from which benefit would emerge. Neither can know too much about the other's problems, and a free discussion about the design of all pattern equipment would certainly assist in reducing the moulding problems submitted to the foundry in the shape of patterns.

The first intimation the patternshop usually receives when a new design of casting is required is the arrival of the drawing or blueprint, and it is suggested that an ideal arrangement would be as follows:—When the patternshop has considered and thoroughly assimilated the design the foundry executive should be notified and arrangements made for a discussion regarding the pattern equipment. The casting is the product which is desired; therefore, it is essential that the foundry decide the type of equipment which will produce the casting in the most economical method. As the majority of foundry people are not as conversant with drawings as the patternmaker, he should explain to the foundry any details of the design which cannot be easily understood. This interchange of opinions must have a beneficial effect on the resultant patterns.

Whilst the new design is being considered, patterns similar in design can be examined, previous moulding practice reviewed, and experience will be gained by rectifying past mistakes. To construct a successful pattern equipment, one must be expert in interpreting the ideas of the designer as indicated by the drawing. It should be possible to visualise what is represented in order to understand what design of casting the draughtsman wishes to be produced, before construction is commenced from both the moulding and patternmaking point of view.

A thorough knowledge of mechanical drawing and applied geometry is necessary in order to lay out work to the best advantage and to supply those details of construction which the draughtsman has not been able to include in the drawing. It also requires an intimate knowledge of the moulder's materials, equipment and methods as well as moulding-shop practice to determine the various features required of a pattern equipment to meet service requirements of the resultant casting, *i.e.*, machining allowance and to assist in producing satisfactory machining locations.

When the design of the pattern equipment has been decided, the number of patterns necessary to produce castings to meet the customers' requirements schedule will have to be discussed, this being another point which is the responsibility of the foundry. It is usually cheaper to construct a number of similar patterns at the same time than to construct a number of similar patterns one at a time.

It is a personal opinion that pattern design has not received consideration by the departments concerned relative to its importance. In the past, advantage was taken of the fact that sometimes foundrymen were wary of confessing their inability quickly to visualise the shape or size of the required casting from the drawing, and pattern design, therefore, was left to the responsibility of the patternmaker, who perhaps, quite naturally, constructed a pattern which would certainly mould, but not always mould to the best advantage.

MATERIALS USED

The following materials are used in the construction of production pattern equipment:—Yellow pine; mahogany; plaster of paris; cast iron; brass; aluminium alloy, and neutral stone compound. Each of these materials possesses admirable characteristics, and when correctly applied excellent results are obtained. The following is a brief account of their general application.

Yellow Pine (*Pinus Strolius*)

The characteristics of this wood are too well known to require any comments. It is an excellent wood for the construction of "master" patterns and coreboxes, possessing a soft even grain which is of great assistance when being hand or machine worked; a well-seasoned wood will not shrink or warp either in the foundry or in storage. This wood is not often used in the construction of wooden production patterns because it does not withstand the rough usage foundry conditions impose.

Mahogany

This wood is very widely used for the construction of production pattern equipment. It is obtainable in various grades, all suitable for pattern work, but obviously the cheaper grade has not the qualities of the more expensive grades, the grain being brittle (to use a workshop term, "bony"). The other grades when well seasoned are free cutting with even grain. Although this wood is always referred to as a hardwood, it is easily hand-worked.

The wood must be well-seasoned; it is useless to expect a patternmaker to construct satisfactory pattern equipment from unseasoned timber, but when well seasoned it will withstand the varying conditions of the foundry—neither shrinking nor warping when in contact with hot and wet sand. It does not distort easily, but it is liable to splinter if the vent wire comes into frequent contact with the pattern surface. When used in suitable combination with either aluminium or brass very satisfactory results are obtained from it.

Plaster of Paris

Plaster of paris is used in the construction of master patterns. It is obtainable in three grades, coarse, fine and super fine, and satisfactory results can be obtained when using the fine quality. Plaster of paris is chiefly used for making casts of undercut sections of the wooden master patterns, also for making casts of production coreboxes. This method of pattern construction will be fully explained later. One advantage of using plaster of paris compared with wood is that it can be cast into any desired shape. In preparation clean water must be used and when stored the material must be kept clean and dry. A certain amount of practice is necessary to become familiar with the degree of consistency required to produce satisfactory results; it is inclined to be messy in use, and speedy work is essential because it solidifies quickly. The plaster cast when completed is rather fragile and must be moulded with care. Usually the moulder is so afraid of breaking the cast that he does not need telling to be careful. As a very smooth finish can be obtained it considerably assists in the preparation of a satisfactory mould.

Cast Iron

There is no doubt that this is the most extensively used metal for the construction of metal patterns, the chief disadvantage being excess weight, which causes unnecessary fatigue. Its use in the construction of production pattern equipment is therefore limited. Patterns to be used on Sandslinger machines are usually constructed of cast iron because the surface does not become pitted or defaced by the minute slag inclusions in the sand. Coreboxes to be used on the core-blowing machine are also made of this metal. When correctly prepared, cast-iron pattern equipment gives excellent service, withstanding the rough usage with satisfaction. Although this metal is inclined to be brittle breakages are rare, though the majority of patterns and coreboxes are approximately ¼ in. metal section.

Aluminium Alloy

Aluminium alloy is used in the construction of all types of metal pattern equipment where service conditions are not too severe. The production pattern equipment is made from a commercial alloy of the following composition (3.L.5 alloy):—Zinc, 12½ to 14½; copper, 2½ to 3; iron and silicon, 1.5 per cent. max., and aluminium remainder.

Providing the equipment is suitably prepared a very satisfactory service life is obtained. One disadvantage when in production is its tendency to become pitted if the vent wire is not carefully used. Aluminium-pattern alterations or repairs cannot be carried out so easily, although an aluminium solder of the following composition gives fairly satisfactory results after a slight experience in its application:—Tin, 81; zinc, 11, and aluminium, 8 per cent.

Brass

Brass has been in common use long enough not to need any comments. It is used in the construction of "spray" patterns, which, being of unit construction, have to withstand a considerable amount of rough usage, and the fact that they will bend rather than fracture extends their service life considerably.

Ordinary scrap brass is used in spray pattern construction; additions of varying quantities are made of copper, zinc, and lead when necessary. Although an excellent finish is obtained before the equipment is placed in production, this finish appears to improve as production progresses.

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* A Paper read before the East Midlands Branch of the Institute of British Foundrymen, Mr. W. T. Evans presiding.

Stone-like Compounds

Neutral stone compound is a commercial product, of which there are several proprietary brands. It has been developed especially for the making of pattern plates and "oddsides." Speed is an important feature of its application, and it has an advantage over metal because it does not contract or expand. The compound produces moulding patterns with accuracy and gives exceptionally clear definitions, dependent of course upon the condition of the mould into which it is cast.

The method of making a pattern plate of this material is similar to that used when making a metal pattern plate. A good clayey moulding sand is required and must be rammed hard. The mould should be dusted with good-quality plumbago and brushed into the surface of the mould to fill up all the pores in the sand. The surface should then be skin-dried with a blow-lamp or gas jet, or methylated spirits can be used.

The compound, which is in powder form, should be thoroughly mixed with the liquid which is supplied in a clean bucket to a consistency that will readily flow. When cast, the best results are obtained by allowing to set in a normal temperature. When the compound pattern plate is thoroughly hard, which will be in 12 to 16 hrs., it can be removed from the mould and finished off. When set the surface can be buffed without fretting, and consequently a very high polish can be obtained. This compound is used fairly frequently in the construction of twin plate patterns which are cast into cast-iron box-parts to give increased strength. Great care must be taken in the preparation of the pattern mould because good pattern equipment cannot be cast from an indifferently prepared mould. An example of the application of this material will be shown later.

PATTERN LAY-OUT AND CONSTRUCTION

The designing of pattern equipment to obtain the greatest economy of time and material is a very important feature of pattern construction. It has been found an advantage first to lay-out the design full size, if possible, or on as large a scale as can be done, on a smooth board, showing one or two views which are not shown on the drawing. This assists in obtaining in the mind a correct picture of the required casting. If the views shown on the drawing are copied, it is possible to commence pattern construction without having thoroughly visualised what the resultant casting will be like.

This lay-out should be made as accurately as possible, according to the contraction rule, and should clearly show all details of construction as well as all pattern partings, coreprints, corebox joints and loose pieces, if any; moreover, pattern taper should be shown. The sectional view is usually very useful to the foundry because it shows the sectional thickness of the casting. When the lay-out is too large to be accommodated on a board, it can be set out on white chalk lines on the patternshop floor.

The lay-out need not be any more or less complicated than the design requires. This lay-out is also useful as a check on the draughtsman's errors; drawing mistakes have been found by this method of checking, which would have considerably increased the pattern costs if they had not been noticed until the construction had advanced.

Sometimes patterns require to be made in pairs because of right- and left-hand design, and with a comprehensive lay-out it is often a simple matter to design a corebox which can be easily handed to produce both sets of cores. When the construction of a wooden pattern is commenced, all pieces or sections as they are constructed should be marked out from a centre or datum line, this line being clearly marked on all pieces. This will facilitate the pattern assembly. The individual pieces can be hand or machine worked to the required shape and, as each piece is assembled, the shape of the pattern is gradually formed. To assist construction, it is desirable to reduce hand-working to the minimum; with the introduction of precision woodworking machinery, the construction of pattern equipment has been expedited.

With production patternmaking, sturdy construction is essential, and aids to patternmaking, such as leather fillets, plastic wood and bees-wax, should be used very sparingly, because when a pattern is continually in and out of production these additions either wear off or become loose and require attention. A superior pattern is constructed when all fillets are worked integral with the general construction.

There are, generally speaking, four forms of wooden pattern construction:—The box-shaped pattern; the pattern built up of segments or staves; the plate-pattern, and the solid pattern.

Box-Shaped Pattern

The box-shaped pattern must be constructed in such a manner that it will be strong enough to withstand any abuse it may receive in the foundry. The most satisfactory method of construction is first to construct a framework something similar in principle to the iron girderwork which is erected in the construction of a

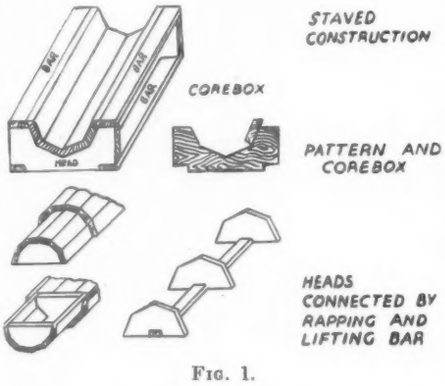


FIG. 1.

ferro-concrete building. This framework should be so designed that all pattern surfaces will be substantially supported; the correct construction of this framework is the most important feature of this shape of pattern.

When the framework has been completed and the pattern surfaces are being assembled, it is essential that all the timber which is to form the vertical surfaces should be cut so that the grain travels in the same direction as the pattern will be withdrawn from the mould. To allow for any shrinkage across the grain, narrow strips are fastened at each corner, and the top and bottom surfaces are then cut to fit inside the vertical surfaces. With this method of construction, there is no end-grain that can adversely affect the removal of the pattern from the mould, and further, a pattern constructed in this manner will not alter dimensionally through the varying conditions operating in the foundry.

Pattern Built of Segments or Staves

The pattern built of segments or staves is usually of circular design. The purpose of segment construction is to have the grain of the wood following the outline of the design, thus ensuring great strength as well as rendering it easier to form the necessary shape. This construction is the strongest of all, and it can be easily adapted to innumerable designs which require to be hand worked or machined. End grain being entirely eliminated, a very good finish can be obtained. As is well known, the segments are usually a section of a circle, dependent on the size and shape of the construction, and are built up in successive layers called courses, each segment half covering the segment below.

Staves are usually used in the construction of a cylindrical design. This method can either be used to construct a pattern or a corebox. The heads which support the staves must be strong, because the strength of the construction is dependent on them. Usually the staves run the length of the construction, which has the advantage of minimising the dimensional inaccuracy due to timber shrinkage. A pattern constructed by the method shown in Fig. 1 will remain perfectly round a very long time, regardless of adverse conditions in the foundry.

Plate Pattern

The plate pattern is sometimes a very frail construction, this of course being dependent on the design. No matter what the design of the casting may be, however, a pattern strong enough to withstand the service conditions of the foundry can be constructed by the following method:—First construct the moulding board on which the pattern is to be mounted, then build the pattern on the board. Quite different methods of construction can now be used to form the pattern, as it has not to be a self-contained unit. The moulding board gives support to the pattern, all ribs or bosses or facings can be firmly secured to the board, and there is sufficient strength to support any metal components that service conditions make necessary. This principle of construction can be applied successfully to an unlimited number of designs.

Tooth End

The pattern shown in Fig. 2 illustrates one application of this method of construction. The circular portion is constructed of hardwood and built on the moulding board and turned to the necessary shape on the board. A master pattern was made of the fingers, and these fingers, 39 in number, were cast in brass, worked to shape and secured in their correct position by screws. This method of construction was quicker and cheaper than constructing a metal pattern, and the result was quite as satisfactory.

The solid pattern is used frequently in the construction of master patterns, as it is often quicker to form the pattern from a solid piece of timber than to build it up. Since its period of service is short, strength is not necessary. Convenient designs of production patterns are made solid, but general application is rather limited, due to difficulty in obtaining suitable timber and excessive cost.

These four forms of pattern construction can be used individually or collectively in the construction of a certain design, and the knowledge of how and when to combine these different features is one of the arts of patternmaking.

Metal Patterns

Metal patterns are extensively used for production moulding, and, providing care is taken in their construction, a very satisfactory equipment is produced. When a number of similar patterns are required it is often cheaper to make metal patterns, but owing to the fact that a master pattern is required first, the initial expense is greater than when a wooden pattern is made. This one disadvantage does not restrict their general application; all types of casting design can be produced, and there are no difficulties of construction.

Metal patterns are generally produced from wooden master patterns, this being the quickest and cheapest method. Plaster of paris is another material which is used, and when used in combination with wood excellent results are obtained.

When the most satisfactory method of moulding for the required casting has been decided, the wooden master pattern is made exactly as designed on the drawing, the moulding of the pattern being disregarded entirely. Only when the master pattern is completed is the method of moulding reviewed, and any section that will not mould is noted.

A plaster of paris cast is then made of the undercut section, sufficient material being

allowed to permit the formation of the core print. The cast when set is removed from the pattern and worked to the necessary shape. This plaster cast (Fig. 3), being the shape of the undercut section and coreprint, is now used as a pattern for the moulding of another plaster cast which, when completed, is used to produce the production corebox. When both plaster casts are completed, one is secured to the wooden master pattern to form a core print, which locates the core produced by the corebox constructed from the other plaster cast. This method of constructing coreprint and corebox from plaster casts entirely eliminates all defects which might be caused through core and mould not matching up, and in consequence causing distortion of the casting surface.

Wherever possible machining allowances are made on the master pattern to reduce hand working to the minimum. It has been the usual experience that the construction of a satisfactory wood pattern is more easily accomplished than the construction of a satisfactory metal pattern. Generally, the skill of the wood patternmaker is superior to the skill of a metal patternmaker. This perhaps is due to the fact that a number of metal patternmakers have drifted into the patternshop from another section of the engineering trade. The difference in the skill of a tradesmen who has served his apprenticeship to metal patternmaking and one who has drifted into the patternshop is very noticeable.

SIMPLE TYPES OF PATTERNS

Generally speaking, no two patterns are alike. Patterns constructed to solve certain moulding problems resulting from the external and internal shape of a design are never identical, although the methods of construction may be similar. It must not be inferred that each problem of construction is in each case confined exclusively to one particular type of pattern, because a number of problems could be embodied in a single pattern.

When studying patternmaking, it is essential thoroughly to understand each type of simple pattern, because a careful study of the simple type of pattern is essential if the principles they represent are to be understood and recognised when they occur in more complicated forms. The ability to do this is necessary successfully to determine the type or combination of types to be adopted in the construction of any new design.

Type 1.—"Flat Back"

This type of pattern is the most simple pattern to construct and mould. It is usually a one-piece or easily-constructed pattern, and may be a replica of the required casting or perhaps be partly cored. The taper to facilitate removal from the mould is usually in one direction, dependent on the service conditions, this being a point for the patternmaker to decide. The principles of this pattern being so well understood, no illustrations are necessary to show its application in production moulding.

Type 2.—"Two-Piece" Pattern

This is the simplest form of a jointed pattern. It is made in two sections, not necessarily equal sections, these two sections being held in the correct relative position by means of dowels. A cylinder with a flange at each end is a simple illustration of this type of pattern. Such a pattern is easily mounted on a board, either on single or twin boards. The advantage of a "two-piece" pattern construction is that a straight moulding joint is produced, and there is no necessity to form a joint, as would be the case if the pattern were made solid.

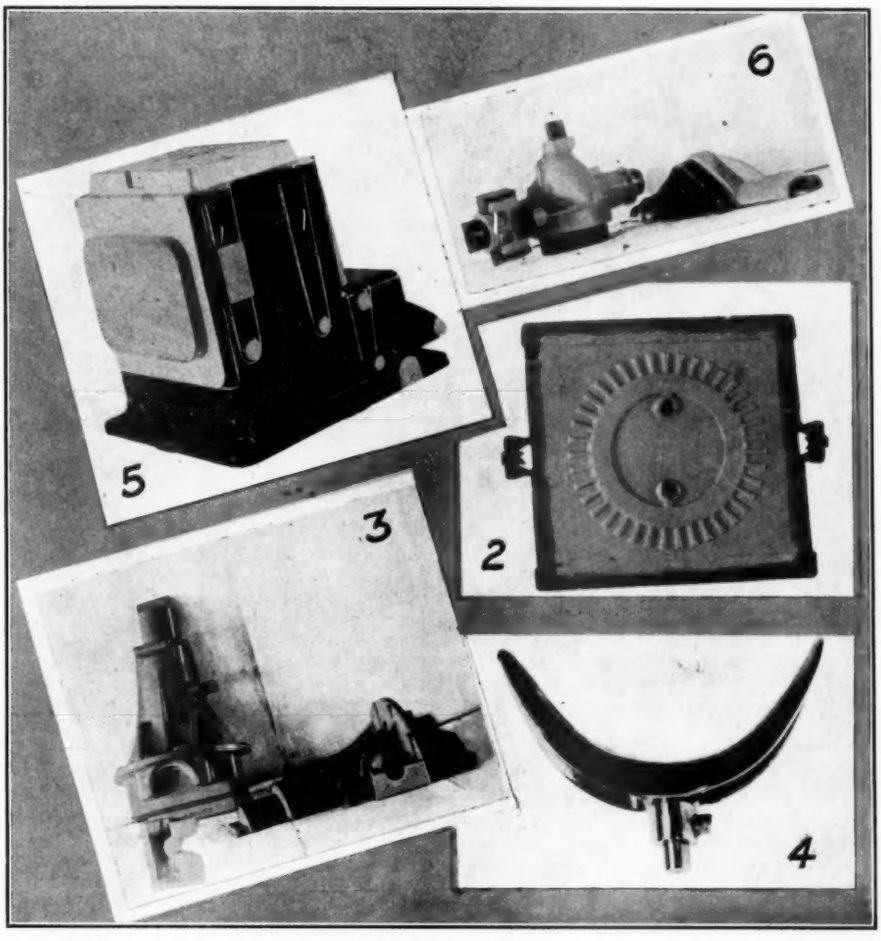
Type 3.—"Three Part" Pattern

This type of pattern usually consists of a "two piece" pattern, but its design is such that it cannot be drawn from the mould if moulded with only one joint; therefore, a moulding box with three sections must be used. The "three part" pattern is seldom used for production moulding. It is common practice to dispense with the third section of the moulding box by incorporating a cored section in the pattern equipment, and a practical application of this principle will be shown later.

Type 4.—Patterns with Loose Piece

Many suggested designs of castings are such that projecting parts form impractical moulding propositions, because these projections prevent the pattern being removed from the mould. The projection may either be placed in the cope or drag. These projections have to be formed by loose pieces which are fastened in position on the main body of the pattern by loose dowels or "skewers."

To permit the drawing of the main body of the pattern from the mould, the skewers are removed as the mould is rammed, and when the body of the pattern is withdrawn, the loose pieces remain in the mould and are drawn carefully into the cavity left by the pattern. To avoid the general use of loose pieces on production patterns, cores are substituted wherever possible. If this is not possible, the projections are positioned by a dovetailed piece which is made flush with the surface of the main body, or sometimes a change in design may be suggested.



Figs. 2-6.—Examples of Patterns for Production Moulding.

Type 5.—Patterns Moulded with Drawbacks

This type of pattern is used almost exclusively in the production of large castings. Drawbacks are iron plates inserted in the mould to carry undercutting projections which cannot be drawn into the mould, or they can be sections of the pattern itself. They are called "drawbacks" because an open space is left behind them in the mould, into which they are drawn with the portion of the mould which they carry. They are used more frequently on jobs moulded in the foundry floor or in dry-sand work.

The author has never seen a "drawback" used to mould production pattern equipment in his foundry, although, as Fig. 4 shows, this method of moulding is still considered a practical proposition by one of his customers. This pattern was submitted for the production of 50 castings, and needless to say it was not used as submitted; the boss on the stem was removed and made to work loose and was drawn into the mould when the main portion had been withdrawn.

PRODUCTION PATTERNS

The patterns selected to be used as illustrations are patterns which have been successfully used on production moulding, and the descriptions of all pattern equipment will necessarily have to be brief.

As this is not a Paper dealing with moulding no reference will be made to the location of gates and feeders, although several illustrations are given where such are attached to the patterns. These components are designed by the foundry, and as they are considered an integral part of the pattern equipment they are constructed and secured in position by the patternmaker. There are unquestionably alternative methods of moulding the examples shown, but it must be understood that the methods shown have proved very successful, and the majority of these patterns have been in constant production ever since they were constructed.

Switch Box (Type 4)

The pattern shown in Fig. 5 is an example of the box construction. The sides with the

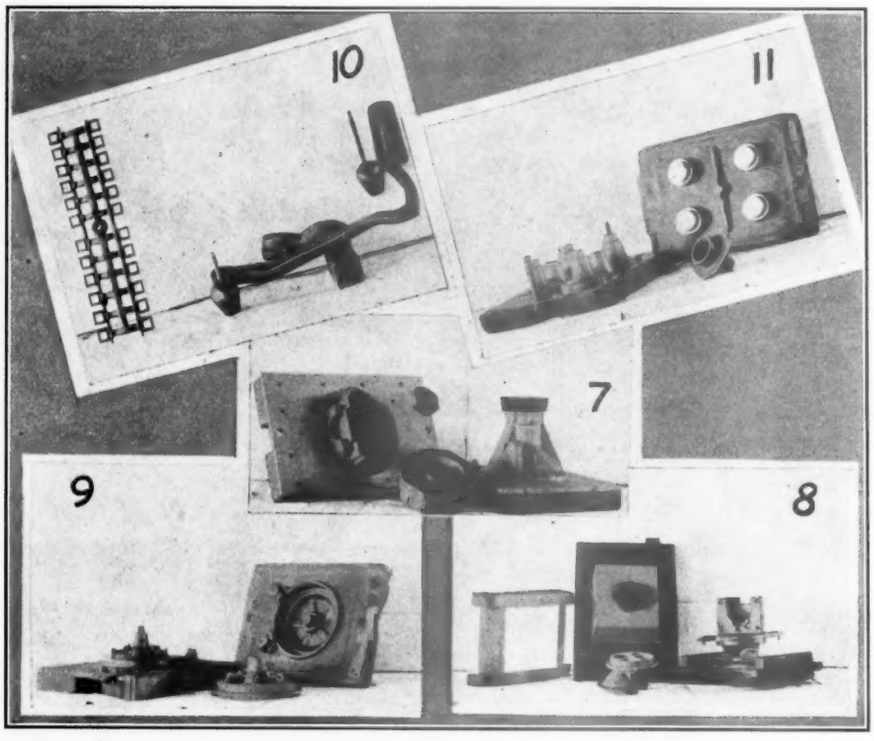
grain running in the direction in which the pattern will be withdrawn from the mould are assembled about a well-constructed framework; corner strips are assembled at the four corners to allow for shrinkage across the grain, and each end is fitted inside the four sides. This pattern illustrates that by thoughtful construction, the incorporation of loose pieces need not adversely affect the strength of a production pattern. A number of the projections carried by the loose pieces can be seen, the total being seven. To design and produce cores to form these projections would in this instance have considerably increased the cost of the pattern construction, and moulding time would not have been reduced.

As this design is one that the author's foundry does not produce in sufficient number to warrant the mounting of the pattern on a board, it is worked loose, but it could very easily be

Differential Carrier (Type 3)

Fig. 7 illustrates a pattern which is an example of the combination of hardwood and metal, the main construction being wood with metal facings. The covering core and small flange are of aluminium; the main flange and ribs are brass, and the face of the main coreprint and horns are sheet brass. This pattern has given excellent service, withstanding the rough usage in the foundry admirably. It will be noticed this is a three-part construction, but to dispense with the three-part moulding box, the covering core is used This portion is made loose and the cope is of sufficient depth to produce a mould to the face of the covering print.

The loose piece is removed before the cope is withdrawn, to allow the removal of the pattern; the covering core is an added advantage. When the main core has been assembled and the cope replaced, the exact position of the core in relation to the mould can be seen and adjustments made, if necessary, before the covering core is placed in position. To assemble the two halves on twin plates, the two plates are secured with the moulding faces together and located in the box-pin holes. A predetermined diameter hole is machined in the plates, and a similar diameter dowel is formed on the two halves of the pattern. The casting weight is 32 lbs.



FIGS. 7-11.—EXAMPLES OF PATTERNS FOR PRODUCTION MOULDING.

mounted. The two hinge flanges would require coring out beneath the centre of the hinge boss, and the print on which the pattern now stands would have to be removed. The casting weight is 184 lbs..

Rear-Axle Housing (Type 2)

Fig. 6 shows a hardwood pattern of segment and stave construction, two cylindrical portions being assembled on to a main body. It will be noticed how easily the mould joint will be produced through jointing the pattern at the centre line. The pattern was for an experimental design, and if at some future date it is placed in production, metal facings will be substituted wherever considered necessary. The flanges and coreprints at each end of the axle tube, the coreprints on the cover face, all ribs and fragile projections will be made of either brass or aluminium, as provision was made in the construction to allow these portions to be easily removed, so enabling replacements by metal.

This pattern will no doubt be mounted on twin boards, and when mounting very great care must be taken to ensure that the two halves match up correctly. Usually a centre line through the box-pin holes is taken as the datum line. The casting weight is 109 lbs.

Gearbox End Plate (Type 3)

The pattern equipment shown in Fig. 8 is an example of the three-parted pattern designed for production moulding. The block coreprint dispenses with the second mould joint. It will be noticed that the portion of the casting from the unmachined face of the main flange to the face on which the casting stands is formed by the core. The pattern equipment is an excellent combination of hardwood and metal. The block coreprint is constructed of wood. Unfortunately the aluminium portion of the pattern which is on the opposite side of the board cannot be shown, but the top face of the casting shows the design.

A frame-constructed corebox with a brass replica of the outer casting shape is used to produce the block core and the brass body is jointed to assist core production. It is located in correct position by dowels. The strickled face of the frame, as well as the internal surfaces, are faced with sheet brass, and a cast-iron corebox constructed from a plaster cast is used to produce the centre core. The casting weight is 12¼ lbs.

Front Wheel Hub and Brake Drum (Type 2)

Fig. 9 shows a brass pattern mounted on twin plates; it was constructed in three sections, the first section forming the internal surfaces of the brake drum and hub. The mould joint was formed at the edge of the strengthening flange and along the centre line of the five arms. This section was machined all over and the five arms were assembled after the machining was completed. The second section was a coreprint in the form of a block machined an exact fit inside the first section, and the third section was a shell that fitted over the second section to form the outer surfaces of the hub and brake drum.

It will now be understood that section I is constructed to form one-half of the pattern and section II and III the other half. The mould joint along the centre line of the arm was machined to templates, and a perfect joint was formed. The five arms on section III were milled on a radial miller, and their position was perfect. The battens fastened beneath each pattern should be noted. If the design of the pattern be such that a considerable amount of pattern protrudes beneath the pattern plate, a box section is constructed about the pattern to prevent it becoming damaged in the foundry. The casting weight is 13¼ lbs.

Conveyor Chain Link (Type 1)

Fig. 10 shows a "spray" pattern, and it should be noted that there are 24 patterns assembled on a ⅛-in. diameter bar which forms the coreprint. The important feature of this equipment is that each pattern must be exactly the same size as the other 23, because the castings must be interchangeable. All assembly fits are as cast, and the section of finished chain shown illustrates the extreme accuracy with which the castings are produced. The "spray" is constructed of brass, and considering the design, it is a fairly robust pattern equipment. The casting weight is ⅜ oz.

Clutch Pedal (Type 1)

Fig. 10 also shows a "spray" pattern of unit construction, and it will be noticed that the length of the pedal arm necessitates the pattern being constructed of a metal that will not readily fracture. A wooden master pattern is first constructed, and the brass production pattern is moulded from the master pattern. The ¼-in. brass rods, which are incorporated in the construction to assist to steady the pattern when being withdrawn from the mould, are noteworthy. To prevent a new moulding joint having to be produced for each mould, this pattern is moulded in an "oddside." The casting weight is 3½ lbs.

Front Wheel Hub (Type 2)

Fig. 11 shows an aluminium pattern equipment, with four patterns mounted on twin plates and the mould joint at the face of the flange. The patterns were constructed from a master pattern, and the design is such that it was possible to machine all the surfaces. To position the patterns on plates dowels of a predetermined diameter are constructed on the face that assembles to the plate, and eight holes of a similar diameter are machined in the plates.

It will be noticed that these castings are produced with the full flange on one plate. This method of production increases inspection difficulties, because it is impossible to check casting off-set without the use of calipers; to overcome this difficulty three oblong strips, ⅛ in. by ¼ in., are placed in a position on the plate relative to the outside diameter of the flange, and if these strips are not exactly on the outer flange diameter of a finished casting, the casting is off-set. The casting weight is 6¾ lbs.

(To be continued.)

Treatment of Castings after Casting*

By H. HERDMAN

Efficiency has been defined as "the controlled application of progress to achieve better results." This concise statement emphasises a factor which, although it is extremely important, is too often neglected when new methods or machines are introduced. That factor is control. It is insisted that if any alterations to existing conditions are to be completely effective, men must be trained to new circumstances which do not finish by producing simple operations.

In a dressing shop dealing with approximately 3,000 castings a week, control and a proper distribution of the work ensure the general flow of the castings through the shop, which helps to satisfy both progress and sales departments, although they will never be completely satisfied.

Eliminating Wasteful Handling

Unnecessary handling can be avoided in the first stages by having dumps for light and medium castings at points where the work enters the shop. Heavy castings are in a category apart. A jobbing foundry will have more difficulty in this direction than will be the case where the work is more of a repetition character. On Tyneside, foundries in general deal with a large variety of work, and it is on this basis that fettling is being reviewed.

The degree of accuracy needed in the fettling shop depends on the class of work handled, and consequently the equipment necessary to achieve economical working varies accordingly.

The finish of a casting is highly important to the sales department, and no matter how good the general shape and skin may be, poor fettling can spoil the appearance. Small castings usually call for more work and greater care, because of their intricacy, and as the greater number of these have to undergo many subsequent machining operations, a knowledge of certain important points is required, or there will be inevitable trouble in the machine shop. Such examples as fettlers blending out a cross joint, or over-fettling a part used for a machine surface, can be recalled to mind by most foundrymen. Smoothing the face of a rough casting due to a burnt mould or poor sand is an operation which calls for a certain amount of artistic skill, if the result is to be acceptable. Appearance demands consideration and should not be left to the machine-shop fitter.

In the event of a number of castings to one pattern being required, it is advantageous to have a sample cast. This will show up, as far as the moulding is concerned, any crossed joints, inaccurate coring, drawn parts, accumulation of gas holes, and the like. A patternmaker or inspector controlling such a casting, in the fettling shop, can detect such faults and have them remedied, and thus the expense of fettling faulty castings is saved.

When dealing with faulty castings, it is necessary that they do not lie in the shop for any length of time, awaiting a decision as to their fate. It is advisable to have a reject bench as near the fettlers as possible, on which can be placed faulty castings, as they are noticed. These castings should be examined daily by the responsible foreman moulders, and a note made of the faults with a view to rectification. In cases which are beyond repair, a replace order should be sent to the foundry immediately. This helps to maintain production and also facilitates the work of the progress department.

The fettling shop, being the last department in the sequence of production, is generally held responsible for any hitch in delivery. Therefore, it has to be seen that there is no delay in getting the previous day's cast disposed of. The aim should be to pass each day's cast through the sandblast, and have it well on the way to the despatch department before the next day's cast arrives. It is a difficult rule to keep, but once established, should not be broken. The chaos resulting from allowing even two or three days' casts to be piled in a heap at the sandblast, each cast having its quota of faulty castings, is best left to the imagination.

It is to prevent such happenings that control is essential, and an organised routine is necessary for dealing effectively with small castings especially. Such a system goes a long way towards laying the foundations for a perfect fettling shop.

Sand Blasting

In the cleaning of small and medium castings the sandblast plant plays an important part. Of course, the running of the sandblast is a costly item, but against this the maximum amount of output can be obtained by a little organisation on the part of the foreman or person in charge. Two bogies should be available at the sandblast, one of which can be loaded while the operator is busy with the other inside the plant. If a foundry specialises in the manufacture of intricate castings such as cylinder blocks, cylinder heads, compressor cylinders or locomotive cylinders, a sandblast is not only desirable but essential for loosening and blowing out the cores. It has been proved, in the foundry to which the author is attached, that the sandblast can be of greatest assistance in removing the cores in hydraulic cylinders and rams up to 20 ft. long. The entry hole to these is very small in the bore, and without the assistance of the sandblast the time taken to clean them would have been more than trebled. Of course, a special nozzle up to about 10 ft. long had to be adapted for this operation.

Pneumatic Tools

The pneumatic tool is one of the more recent aids to production. A modern fettling shop without pneumatic tools would be like a ship without a rudder. These tools can be made for almost any operation, such as removing cores and risers, stripping down and dressing joints, and they are much more efficient and quicker than the hand tools. It must not be thought that their manipulation is easy to acquire, but once mastered it is difficult to imagine a workman returning to the more laborious task of working with hammer and chisel.

A complete range of chisels should be supplied to the operators of these tools, and such chisels should be of the best-quality steel. The correct heat-treatment must be *insisted* on, when hardening and tempering.

In the dressing of iron castings which call for a large amount of chipping, these tools are used to the utmost extent. The specially-hardened chisels withstand the cutting of the toughest metals to an amazing degree. Used on castings where heavy chipping is necessary the pneumatic chipping hammer is an ideal machine, as the chisels cut through the metal with incredible speed and leave a finished surface not to be equalled by hand work.

Sometimes a fettler has to deal with a badly shaped casting or one in which a cross joint needs a lot of blending away. The pneumatic chipping hammer makes the work light. Not infrequently a mould is badly burned and the sand adheres and burns into the casting. A pneumatic hammer with a small bumping tool is the best means of surmounting this difficulty, and the work takes half the time which is normally taken by hand.

Where runners and gates have to be removed from a casting, the cross-cut chisel makes light of the job, whereas formerly with a rod and chisel and heavy hammer it required many hours of hard work from the men concerned. The stripping of sand and the removal of cores are also simplified by the use of long chisels, which work equally well as the shorter tools used for chipping. They can be set to any desired shape, and the vibration of the hammer tends to slacken the hard sand and therefore enables the workman to complete the job in much less time than with the old methods. For light castings the pneumatic hammer is just as efficient, producing that finish which is so desirable to firms ordering them.

A Concrete Example

As a matter of interest, the author would like to cite the following example as to what can be done with the aid of the sandblast and pneumatic hammers. At the author's works, there was recently completed a contract for 227 sets of locomotive castings for a railway company. This consisted of thousands of castings—probably of the order of 100,000—such as cylinder covers, pistons, piston-valve liners, axlebox guides, etc., and it was possible to fettle these at just over 10s. per ton, working out at 2s. 4½d. per ton for sandblasting and 8s. per ton for fettling. This, it should be added, was to the complete satisfaction of both the firm and the fettlers, who made 8s. per ton, or time and a quarter.

Steel castings, which call for much more vigorous methods of chipping and scaling, can be dealt with just as easily. Where, in the past, brackets and seams called for the use of rod chisels and quarter hammers for long periods, and required two workmen, to-day the pneumatic hammer executes this operation in much less time. Scaling and caulking are also brought to perfection by the use of blank-ended or dummy tools. The surface of the casting is preserved and is free from marking as in hand finishing.

Where more highly finished work is dealt with, the rotary grinder plays its part, on both iron and steel. These machines have revolutionised the dressing of castings, and, once mastered, they are simple and light to operate. The uses they can be put to are practically limitless. For grinding level surfaces, levelling or radiusing, they are ideal. The stones used can be procured in different grades, according to the class of metal to be ground, thereby enabling the workman to produce a perfect job. Where work of a difficult nature has to be performed, which means the use of hammer, chisel and filing in small spaces, taking up considerable time, the rotary grinder solves the problem, since it completes the operation with speed and perfection.

Dressing of Steel Castings

Much time and expense can be saved in the dressing of steel if the following facts are noted. On being received in the dressing shop, steel castings should be stripped down and then sandblasted. The oxy-acetylene burner should be as near the sandblast as possible, thereby saving unnecessary handling in transit.

The burner will quickly accomplish the task of removing the heads, runners and thick flash, after the sand has been removed by the sandblast. The removal of the heads and runners is finally completed by an all-electric grinding machine. This machine and the oxy-acetylene burner complete the work in a modern foundry much more cheaply and efficiently than the band saw and planing machine of former days, providing that the emery stone used is of the correct grit and grade.

Welding

After the grinder has finished these operations, the casting should be carefully examined for faults, such as pulls and draws. These should be carefully cut out for welding where use is made of the carbon-arc welding set, which burns to the bottom of all draws and bad parts.

* Paper read before the Newcastle-upon-Tyne Branch of the Institute of British Foundrymen.

It is advisable that all welding should be done before annealing. The welder should pay great attention to machine faces, and should take particular care in removing all slag in the process of welding, so that after machining the weld is perfectly clean. All welds should be firmly pinned in after welding, thus ensuring a perfect joint.

There are three different processes of welding which can be used on steel. The carbon-arc system, already mentioned, is the quickest method where there is considerable building-up to be done, or large holes to be filled up by using steel punchings. Secondly, electric rod welding is a popular form of welding extensively used for all classes of steelwork, and can also be used on cast iron with very good results.

Oxy-Acetylene Welding

The third method is oxy-acetylene welding, and is the correct way to weld cast iron (if it *is* correct to weld cast iron) where the fault is on the machine face. All castings welded by this process must be pre-heated, and for this purpose a gas-stove is a valuable asset. All traces of oil, sand and grease must be removed before attempting to weld, and the part or parts to be welded must be cleaned thoroughly. A pre-heating temperature of about 700 deg. C. is all that is necessary. Having attained this heat, the operator draws the castings to the front of the stove and commences welding it. He should not allow the weld to cool rapidly or subject it to drafts, or a hard and practically unmachinable surface will result. The operation being finished, the casting is returned to the furnace, re-heated and then allowed to cool. Oxy-acetylene welding is used for thin pipes, tanks and boilers, amongst many other jobs.

Welding is practically indispensable in a modern foundry. It reduces rejects and costs, and also the amount of work done by the maintenance department. Steel ladles which have burned through in places, as a result of constant use, can be easily repaired by welding on to the inside a steel plate, and are thus made as good as new. This compares very favourably with the older method of sending the ladle to an outside firm to have the patch riveted on. There are numerous other jobs, for example, steel shafts badly worn and needing reinforcement, and teeth broken in a pinion wheel, which can be successfully attended to in the welding shop.

The foreman fettler has many worries, because of the new type of heavy casting passing through the foundry at the present time. When one recalls the former simple nature of heavy types of casting, with their few cores, one can well understand why the fettlers were, in the main, a contented group of workers. They had bedplates weighing up to 20 tons, columns, column bridges, and many other heavy types of casting that could be cleaned in a comparatively short time. The weight of these castings enabled the fettlers to earn their money, not only to their own, but to their employers' benefit. Nowadays they have to contend with a very different type of casting.

Designers have laid themselves out to design engines with a view to lightness, and it might be suspected that the more cores they can put into a casting the better they are pleased! Unquestionably the engineering designer could with advantage spend some time in a foundry, for in many cases, personally encountered, the designer, in his endeavour to lighten the casting by inserting cores, has overlooked the necessity of placing suitable holes to get them out. Many types of turbine castings have this now very familiar failing, and a great amount of energy and time is expended in removing the cores. When this has been accomplished, there is very little weight left in the casting to pay for the labour expended on the job.

Reducing Fettling Costs

The time taken to clean a turbine casting to-day, in many cases, exceeds that taken to fettle a heavy casting of the past, even taking

(*Concluded in next column.*)

Alloys of the Light Metals

A review of the rapidly-extending applications of aluminium and its alloys in all branches of industry, was given by Dr. C. H. Desch, Superintendent of the Metallurgical Department of the National Physical Laboratory, when he spoke before the Chemical Engineering Group of the Society of Chemical Industry in Glasgow on November 5.

Of the three light metals of importance, aluminium, magnesium, and beryllium, said Dr. Desch, only the first two had been used successfully as the basis of light alloys. The use of aluminium alloys was increasing rapidly, the combination of lightness with excellent mechanical properties making them highly advantageous. In Germany, the replacement of imported metals, such as copper, tin and nickel, by home products had led to the substitution of aluminium for copper and brass, for tinplate, and even for stainless steel. The ready oxidation of aluminium, as indicated by its electrolytic position and the high heat of formation of its oxide, was taken advantage of in the artificial reinforcement of the spontaneously formed protective layer of oxide which hindered further action. This reinforced layer formed a basis for a number of protective treatments.

Pure aluminium, stated Dr. Desch, had the highest resistance to chemical action, and was used in the form of sheet. It could be readily welded. Alloys of higher strength were covered with a surface layer of the pure metal, so obtaining a combination of the necessary properties. Certain alloys of aluminium and silicon also had excellent chemical resistance to a variety of reagents, and were used in both the cast and wrought forms, the alloys being easily cast and being tough even in that condition. For special purposes, other aluminium alloys offered considerable chemical resistance to given reagents.

Grouping of Aluminium Alloys

The light alloys of aluminium, explained Dr. Desch, fell into several groups. Some were used in a cast or annealed condition, and owed their strength to elements in solid solution or to the presence of rigid skeletons of a second phase, whilst others were first brought into a homogeneous condition by quenching from the solid solution region and then "age-hardened," either at atmospheric temperature or by heating to a temperature below that of quenching. Some attained mechanical strengths comparable with that of steel.

Whilst general corrosion under given conditions depended mainly on the composition of the alloy, certain forms of intercrystalline corrosion were closely connected with the heat-treatment to which the alloy had been subjected, and the conditions might be fairly critical, so that a treatment, advantageous from the mechanical point of view, might be undesirable on account of rapid destruction by chemical agents. Some of the alloys resisted relatively high temperatures well, so that they could be used as heating vessels or kettles for substances which actually attacked steel.

Magnesium Alloys

Magnesium, said the lecturer, was a readily oxidisable metal, and the spontaneously formed film of oxide was less protective on account of its solubility. It was not so easily reinforced by anodic treatment, but it was claimed that improved methods gave adequate protection. Alloys consisting mainly of magnesium were of importance in aircraft construction and in certain branches of engineering, but were not likely at present to find wide application in chemical plant. The alloys of aluminium containing from 5 to 10 per cent. of magnesium, with or without small additions of other metals, however, had a surprisingly high resistance to chlorides, and were increasingly used in many situations.

The machining properties of light alloys, stated Dr. Desch, had been greatly improved by small additions of suitably chosen foreign metals, giving them "free-cutting" qualities. In considering the advantages of these additions, account must be taken of their effects on both the inherent resistance to corrosion and on the nature of the film formed by anodic or other chemical treatment.

(*Concluded from previous column.*)

into account the use of pneumatic tools. Now where is the foundry going to make up this difference in weight to enable it to make a profit? It can, in the author's opinion, be helped considerably by the moulding shop to do this. For cores in these modern castings, is it not possible to make them in oil-sand? Without enlarging on this, its aid is obvious. Again, grates have to be used, and when they are put into cores they have to be removed. If a little care were exercised in their making, a good deal of the fettler's worry would cease to exist, providing always, of course, that in the design a hole should be placed to enable the fettler to remove the cores. If greater care were exercised in the manufacture of tackle for these jobs, considerable time and expense would be saved, and it would also help in delivery being kept to schedule.

With regard to the finish of castings, to-day this has to be exceptional, whereas in the past a rough casting was asked for, and more often than not received. The foundry now has to produce a highly finished casting, which calls for more time to be spent on the job, and the customer nowadays requires castings with the minimum of machining necessary. These remarks apply particularly to small and medium castings, but the same conditions are extending to the heavier type.

Case-Hardening Methods

A Symposium on Carburising was held recently at Atlantic City under the auspices of the American Society for Metals. Pack-carburising with solid reagents, and gas carburising were considered in a Paper by MR. MARC GROSSMAN, in the course of which he dealt particularly with the mechanisms of carburisation in these two processes. It might be thought, he said, that in the case of pack-carburising, the steel would somehow be carburised directly by its contact with the solid carbon, but simple consideration shows that this is probably not the case. The carburising compound is a fairly fine material, but even so it is not in complete contact with the steel (as for example a liquid would be).

Therefore, if the carburisation took place by direct contact with carbon, it would be expected that the carburised case would be very high in carbon at numerous spots where the steel and the pieces of carbon were in actual contact, whereas the intervening regions would be much lower in carbon. It is known from experience that this does not happen; the carburised case is actually quite uniform. This indicates that the carburisation takes place by another mechanism, and it is generally held that the solid carbon forms carbon-monoxide (CO) gas, and that the CO gas is the agent that actually carburises the steel. This hypothesis is supported, for example, by the types of experiment performed by Enos, who swept nitrogen gas through carburising compound while the compound (with its steel) was at a high temperature, and so prevented the carburisation which would otherwise have taken place. It seems clear from many experiments that pack-carburising takes place through the formation of carbon-monoxide (CO) gas, which in turn reacts with the steel, although this does not exclude the possibility that carbon might carburise iron under certain conditions.

The Steel Foundry*

By J. TONGE

A very prominent railway engineer has voiced the opinion that foundrymen should be classed as the highest rank of craftsmen. It is obvious to-day that employers and engineers are thinking on these lines, and one sees on every hand a more studious and intelligent type of youth taking to the foundry than ever before. Every encouragement is being given to this type, and to-day one is proud to be associated with the industry.

It is evident that during recent years a more sympathetic attitude has been shown by the engineer towards the foundryman. Engineers definitely try to understand and appreciate the manifold problems encountered in the foundry and in the production of steel castings.

Design of Castings

An effort is now noticed in the direction of increased simplicity, in such a way as to obviate unnecessary square corners and uneven thicknesses of section as far as possible, rendering the production of a steel casting much easier. The foundryman has always argued that the engineer can at all times see his work step by step, whereas the foundryman must always be taking risks and hoping for a fair measure of luck.

After taking all precautions—assuring the suitability of the sand at his disposal, its proper tempering and mixing, the correct making of the mould from the pattern, the correct ramming of the sand, the use of clean and proper chaplets and studs, the drying of the mould and necessary cores—comes the intelligent closing of the mould. Then follow precautions to ensure as far as possible that the correct or most suitable type and size of risers are cut in the right position on the casting to be, and that maximum benefit will be obtained from the risers so placed, to obviate the waste of metal which otherwise will follow. The place to run the casting must also have serious thought, to obviate any tearing in cooling down from this source.

After having taken all these precautions, which a good foundry foreman naturally does, the mould is closed and made ready to receive the molten steel from the melting department. At this point the author has often asked foremen of wide experience: "Is it going to be a good casting if you get good steel?" The answer always is: "I don't know. I hope so: I can't see what is happening in a closed mould; I can only surmise." That probably is the wisest answer.

It has been said that the foundry is ever ready to blame the steel and the steelmaker in turn to blame the foundry, but a wise and sensible steelmaker and foundryman will realise each other's troubles and difficulties, since happy co-operation between them will go a long way towards reducing to the minimum the number of foundry wasters. Both steelmakers and foundrymen know that badly-made steel poured into a well-made mould will produce a bad casting, and *vice versa*. The good steelmaker, providing he has the materials which are necessary to produce good steel, has not so much excuse for his product as the moulder, who, as stated earlier, not only has his own troubles but those of a badly-designed pattern, which is often the cause of good steel and a good mould producing a bad casting.

Steelmaking Difficulties

Foundries to-day take their supplies of molten steel either from the acid or basic open-hearth furnaces, the Tropenas or the Stock converter, or one of the various types of electric furnaces.

Years ago a substantial prize was offered for the best definition of steel. Some entrants filled page after page trying to explain what steel really was, but the prize winner was the one who defined it as "pure iron plus carbon." There is no chemical formula for steel. The principal elements found in cast or pig-iron are found in steel but in lesser amounts and in different combinations. In cast iron there are carbon, silicon, manganese, sulphur and phosphorus; in plain carbon steel there are the same elements. Pig-iron, therefore, is the basis of steel. In ordinary cast iron and in plain steels carbon is the predominant factor controlling the quality and physical properties of either metal.

The chemical composition of cast iron and cast steel may be approximated as follows:—

	G.C.	C.C.	Mn.	Si.	S.	P.
Cast iron	3.25	0.30	0.60	2.50	0.06	0.80
Steel ..	Nil	0.30	0.80	0.30	0.02	0.02

A cast iron of the analysis cited would be soft and easily machined, with a tensile strength of 16 to 18 tons per sq. in., whilst the steel containing the same elements in lesser quantities and different proportions would give a tensile strength of from 32 to 42 tons, depending on the treatment and steelmaking process used.

Combined carbon, that is the carbon chemically combined with the iron or steel, determines the degree of hardness in the two metals. The more combined carbon per cent. the harder the metal, coupled with a certain degree of brittleness unless counteracted by the presence of some other element or alloy. It will be seen that, in steel, all the carbon is chemically combined, whereas in iron only a small amount of combined carbon is present with a correspondingly large amount of graphitic carbon. It is this graphite in the iron which makes it relatively weak and soft. Graphitic carbon is the carbon mechanically mixed with the iron, which can readily be seen in the machine shops, and in the dirty state of the machinist who is machining cast iron as against one engaged on steel.

Where the graphite is high in the cast iron, the silicon content is also relatively high, the one more or less in ratio to the other, causing the very open and coarse grain in the iron as against the close-grain structure of the steel where the carbon is chemically combined.

The basis of steel is iron, no matter what type of furnace or process be used, the elements in the iron being removed and then put back in suitable quantities to make steel. For illustration take the Tropenas converter process, which is the simplest theoretical process to understand as to the chemical reactions taking place whilst the iron is converted into steel. This process is essentially an acid process, no attempt being made to remove sulphur and phosphorus, which fact calls for the use of a hematite pig-iron low in sulphur and in phosphorus. The following is a typical analysis of suitable hematite pig-iron:—T.C, 3.5 to 4.0; Si, 4.0; Mn; 1.5; S, 0.2; and P, 0.02 per cent.

An iron of the above analysis will allow the use of from 20 to 70 per cent. scrap steel. That is, the cupola charges may consist of 20 per cent. pig, 80 per cent. scrap; 30 per cent. and 70 per cent.; 40 per cent. and 60 per cent.; or 50 per cent. of each, or 60 to 70 per cent. pig, with 40 to 30 per cent. scrap, depending on the class of casting to be produced, and its size and shape. If it be decided to use a mixture of, say, 50 per cent. pig and 50 per cent. scrap, the cupola iron would be approximately of the following analysis:—C, 2.0; Si, 1.8; Mn, 1.0; S, 0.4; and P, 0.04 per cent.

A Typical Day's Work

During the night the cupola is lighted, and when ready the coke bed is charged, the air blast turned on and the cupola got ready to commence charging the pig and scrap together with the coke and a little limestone. As this is being done, the converter itself is blown hot by means of air blown through the coke fire in the converter. When sufficient iron is down in the cupola the converter is turned down, and by this time must be hot enough to receive the molten iron. It is emptied of its hot coke and turned on its side, and the molten iron run from the cupola into the converter. When sufficient iron is judged to be in the converter, say 2½ to 3 tons, the converter is turned up and the metal level adjusted with the tuyeres (of which there are 7); these are about 15 in. in length, 5 in. by 4 in., with a 1½-in. hole through the entire length, and are set in the back lining of the converter. The correct setting of the metal with the tuyeres is most important.

When this is done, the blast box plate is fastened on, making the box airtight. The blast at a pressure of, say, 2½ in. per sq. in. is turned on and the blow commences, the air skimming the surface of the metal (in the original Bessemer converter the air was blown up through the metal).

The following is a simple explanation of the reactions that take place during the conversion of the iron to steel. The oxygen from the air blown in immediately combines with the molten iron, forming ferrous oxide, the elements themselves in turn combining with the ferrous oxide. First, the silicon present combines to form silicates of iron, which is readily seen by sharp showers of sparks and particles of slag being emitted from the mouth of the converter. The manganese is also removed during this period as manganese oxide, most of which passes into the slag. After about five minutes the carbon begins to be oxidised and removed as carbon monoxide, being burnt to carbon dioxide at the mouth of the converter. The elimination of the carbon is characterised first by a small dull flame and, as the boil increases due to the reaction, the flame becomes brighter and bigger until, for a short while, after about 20 to 25 minutes, depending on the proportion of scrap to pig-iron in the cupola charge, one sees nothing but a huge clear luminous flame. The flame gradually loses its size and luminosity and a decided drop is noticed in the flame, denoting the almost total elimination of the carbon. At this point the blower turns down the converter and shuts off the blast. The analysis of the steel at this stage is now approximately C 0.07 per cent., and Si and Mn practically nil, and in this condition it would be commercially useless. The slag is now pushed back and the required amount of ferro-manganese or Spiegel is added along with ferro-silicon to deoxidise the metal and to make up the steel to the desired chemical specification.

Carbon may be added in several ways; for instance, the author has run molten iron from the cupola back into the converter, or, particularly if the metal be too hot, thrown pieces of pig-iron dipped in water into the converter, or added graphite or anthracite coal into the ladle whilst emptying. Whatever is thrown into the converter is, of course, well rabbled. The ladle is lowered into the pit over which the converter is situated, and the metal is emptied into the ladle and then transferred to the foundry and poured into the respective moulds, either over the lip or through the nozzle. These nozzles have various size holes to suit the particular type and size of casting.

This type of steelmaking is essentially an "acid process," no attempt being made to remove sulphur or phosphorus, the acid lining of the converter making the removal of these two elements impossible. Rather is there an increase in the initial S and P present, owing to con-

* Extracted from a Paper delivered to the South African Branch of the Institute of British Foundrymen, Mr. A. H. Guy presiding.

centration of the bath of metal. Therefore, it becomes necessary to use the best hematite pig, low in sulphur and phosphorus.

The Stock Oil-Fired Converter

The Stock converter needs no cupola for melting the iron before it is converted into steel. The converter, as in the Tropenas process, is first made hot, then turned on its side and hematite pig with small percentages of scrap is charged into the converter by means of a peel. The converter is then turned completely round so that the mouth of the vessel is facing a chamber chequer work. Oil is blown through the tuyeres at about ½ lb. pressure, the combustion of the oil melts the charge, and the flame coming from the mouth of the converter enters the chequer compartment and preheats the brickwork. When the charge is molten, the oil burners are removed and the vessel turned into position, the metal is adjusted through the tuyeres and the blowing carried out as in the Tropenas process, the only difference being that the air blown in is passed through the chequer work, making hot air available for the blowing.

Electric Steelmaking

Out of several types of electric furnaces, the most popular is personally believed to be the Heroult three-phase furnace (basic process). This is circular in shape, the bottom and walls of the furnace being lined with magnesite and silica bricks, the roof made of silica bricks, with the three necessary holes to allow the electrodes to operate on the charge of scrap in the furnace. After bricking, the furnace is dried out by means of fires, which are afterwards cleaned out, and the furnace is made ready for its basic lining, which can be 100 per cent. dolomite (calcined) or with proportions of magnesite (pea size) mixed with water-free tar (hot) to a ramming consistency, the hearth, bottom and banks being rammed with this mixture as hard as possible to the desired shape to allow of the furnace emptying itself when tapping. The roof is then placed into position and the electrodes fitted into their holders and so through the holes in the roof. Coke is put into the furnace and the current switched on, and then on and off at intervals to burn or frit thoroughly the basic bottom and banks. This may take about 50 hours for a 4-ton furnace. After this the coke is cleaned out and the furnace is ready to receive its charge of scrap. A current of 75 volts and 500 to 2,000 amps. is sufficient for the burning out of the furnace.

The charge is usually 100 per cent. clean scrap, with which is mixed a certain amount of lime and ore if necessary, or mill scale, and the current is switched on (several voltages may be available for the melting of the charge—85, 95, 150 and 170 at 4,000 amps.). The charge should melt in between 1½ to 2½ hours, depending on the quality of scrap and the voltage used. There are generally two periods used in this process, the first being the melting or oxidising period, when the carbon, silicon, manganese and phosphorus are removed, the carbon being removed as carbon monoxide, the silicon and manganese as in the other processes. But here there is the removal of phosphorus, which is possible owing to the basic nature of the furnace lining, which allows the use of another base (lime). The phosphorus is oxidised to P_2O_5 (phosphoric acid), which combines with the lime or iron present, forming iron or calcium phosphate, which is removed in the slag when skimming the furnace after being thoroughly melted.

After skimming off this oxidised slag, which should be done as thoroughly as possible, the necessary amount of carbon in the form of crushed anthracite coal is added in the molten bath, with a suitable addition of lime and spar, or a mixture of both with powdered ferro-silicon and fine coal to make a thoroughly reducing atmosphere in the furnace. This is the second or reducing period. When the oxides present in the steel are reduced and rendered harmless, the sulphur is reduced to a minimum in this period, combining with the lime chiefly to form calcium sulphide and, if a thoroughly good slag is obtained, this sulphur will remain stable in the slag. The necessary heat is now obtained for tapping, the usual alloys being added to conform with the analysis required. As a guide, samples may be sent to the laboratory during this refining period. The metal is then poured into the ladle in the usual way and transferred to the foundry.

Surface Finish

The engineer is often disappointed because his steel castings have not the clean finish and smooth surface which he usually expects, and gets, from an iron casting. He finds a pinhole here and there on the surface. This in no way affects the strength of the casting or its physical properties generally, but it is there and consequently the engineer gets annoyed and is sometimes derisive in his remarks. It is now that his tolerance and sympathetic understanding are asked in trying to realise the difference between the action of molten iron on a sand mould and that of molten steel. The high temperature which steel has to attain to cast sometimes from 70 to 90 boxes from a three-ton charge, should be well known. It is this high temperature which has such a penetrating action on the sand and which consequently affects the surface of the casting. Further, the short range of fluidity between the melting point of steel and the freezing point causes trouble in a steel casting, such as hot tears and cracks not generally found in an iron casting. Iron, owing to its greater proportions of carbon, silicon and phosphorus, has a much greater range of fluidity, and, melting at a lower temperature, has consequently a much lower freezing point and naturally does not have the same penetrating action on the sand. Iron keeps molten much longer than steel, and is thus more readily and easily fed.

The feeding of a steel casting is a most important factor and requires considerable forethought in the production of a sound steel casting, necessitating, weight for weight, a far greater proportion of metal in the risers than an iron casting in ratio to the weight of the casting. One is tempted to think at times that far too much metal is used in risers, and the foundryman, if taken to task, would say that he prefers to have a little more metal in the risers and a good casting rather than save metal at the expense of a bad one; but the fact remains just the same.

Physical Tests

The engineers' attitude towards the physical testing of steel castings can be very trying at times. The author has had the opportunity of conducting hundreds of mechanical tests for most of the consulting bodies and bureaux, and he has been interested and sometimes amused by the attitude of such authorities towards steel castings. Some had very peculiar and most unreasonable ideas, and concerned themselves only with the fact that the figures shown on the testing machine did not exactly correspond with their "book of rules," where if 28 tons tensile is specified 27.8 tons is not good enough, or where a bend test should be 120 deg., 115 will not do, in spite of the fact that the average tests may be 28 to 32 tons with 180 deg. bend. For compensation there are others who would fall back in such cases on their long experiences and own judgment, examine the fractures, ask a few good questions and be perfectly satisfied. Then there is the engineer who asks for his casting to be hard and tough with good wearing qualities, about 45 tons tensile, and to machine like butter, and is sometimes disappointed if he does not get it.

The engineer whose men are continually leaving their machines to grind tools through striking hard spots or streaks here and there is worthy of sympathy, and both the foundry and the steelmaker can be blamed for this. The steelmaker is to blame for not having his metal thoroughly homogeneous and his alloys not thoroughly diffused in the metal, and the foundry for improperly milled sand, so that particles of silica have become detached from the sides of the mould and run along with the metal, causing hard, streaky lines in the casting which, on examination, have definitely proved to be silica. This, of course, is like trying to machine the emery wheel. Inconsistent annealing can be a great source of worry in a machine shop, more especially in the larger and thicker castings.

Personal experience of the engineer in South Africa is that he has the interest of the foundry at heart and is most reasonable in his requests.

Firestone Refractory

Firestone, a natural silica rock, has a great resistance to combined fire and abrasion, and, therefore, has been put to use as a refractory.

The grade of stone suitable for refractory purposes is known as "split rock." This has a stratified or laminated structure with a cleavage in straight and parallel lines. The lines of the grain are clearly visible and the split follows these lines quite accurately. The binding material is amorphous (colloidal) silica. Firestone is practically free from contamination with lime or other alkali which would act as a fluxing agent, thus aiding its refractory properties.

A typical chemical analysis of firestone is as follows (per cent.):—Silica, 93.13; alumina, 3.86; ferric oxide, 0.11; ferrous oxide, 0.54; magnesium oxide, 0.25; calcium oxide, 0.10; loss on ignition, 1.43. The physical properties show a crushing strength of 8,000 to 10,000 lbs. per sq. in.; a modulus of rupture of 675 to 850 lbs. (taken on blocks 2 in. sq. in cross-section, 4 in. long, with distance between supports 3 in.); a fusion point of 1,650 deg. C. (Seager Cone No. 32) (it does not soften until very close to fusion point), and a weight per cub. ft. of 133 to 140 lbs. Expansion curve is fairly uniform on first heating of firestone up to about 590 deg. C.

Firestone is quarried by cross cutting with a channelling machine, after which it is drilled and broken out with wedges. Split rock linings of convenient size to be handled by one man, 18 by 12 by 6 in., are typical.

The stone works satisfactorily in the well of the cupola, and can be used in slag holes, but care must be taken not to break the block or use a rod in the hole until the surface has been sintered or glazed by hot slag. The blocks will not stand hammering until the heat has hardened them. If allowed to sinter, they will last a long time.

Experience with this stone, according to "Heat Treating and Forging," showed the following savings:—(1) Used half as much stone as brick; (2) eliminated 8 to 10 hrs. labour of five men on each cupola, as relining took place only once in 24 hrs. as against twice with brick; (3) eliminated one coke bed of about two tons of coke; (4) eliminated the waste of 2,500 lbs. of bottom sand; (5) got better service out of slag-hole and tap-hole blocks, as they are now replaced every 24 hrs. instead of every 12 hrs.; (6) melted 30 tons more of iron in 24 hrs. than possible before, due to less bridging; (7) eliminated the draining and "breaking in" of one cupola with its attending hazards; and (8) savings in direct money by eliminating labour and material were over £20 per day.

The use of firestone for cupola use is increasing very rapidly. Its use has become general over the entire United States.—"Heat Treating and Forging."

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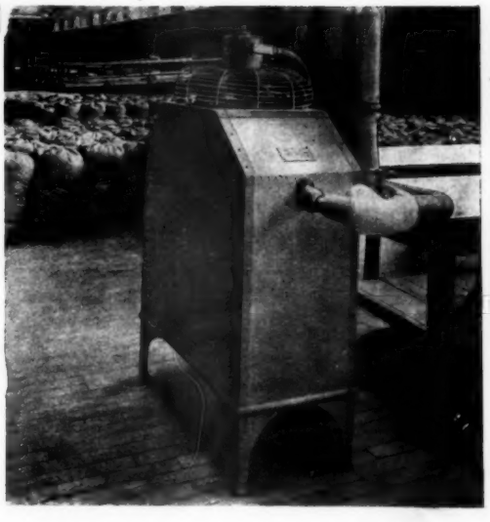

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The Week's News in Brief

Trade Talk

HURST, NELSON & COMPANY, LIMITED, Motherwell, have received an order for 150 20-ton hopper wagons from the L.N.E.R.

MESSRS. POTT, CASSELS & WILLIAMSON, brass and iron founders, of Motherwell, have received a substantial order for sugar machinery.

THE ASSOCIATION TECHNIQUE DE FONDERIE held a meeting in Paris yesterday for the purpose of sanctioning increases in the rates of the annual subscriptions.

A. C. WICKMAN, LIMITED, of Coventry, announce that, as from November 15, the address of their Glasgow office will be 98, West George Street, Glasgow, C.2.

STEEL PRODUCTION in Czecho-Slovakia in January to September totalled 1,705,000 metric tons, as against 1,103,000 tons in the parallel period of last year. Pig-iron output was 1,248,800 tons, against 812,000 tons.

THE FIRM of Buchanan Bros., pressure-gauge manufacturers, of Carrick Street, Glasgow, celebrated its fiftieth anniversary on November 15. To celebrate the occasion the staff and employees were entertained by the firm last Friday.

AN ORDER for a large tin dredge has just been secured by Ruston-Bucyrus, Limited, an associate company of Ruston & Hornsby, Limited, of Grantham and Lincoln. The dredge is to the order of one of the principal Malayan tin companies.

TWO HUNDRED EMPLOYEES of the Stanton Ironworks Company, Limited, at Riddings Ironworks have received a fortnight's notice, with the intimation that they will be called upon from day to day when necessary. An official of the company stated that work was only suspended.

A SECTIONAL MEETING of the World Power Conference will be held in Vienna next year, by invitation of the Austrian National Committee, from August 25 to September 2. The sectional meeting will be followed by one or more "study tours," of approximately a week's duration.

IT IS REPORTED that the British Oxygen Company, Limited, is about to resubmit to Parliament an application for sanction of the Caledonian power scheme. This provides for hydro-electric developments in Inverness-shire in connection with the establishment of a calcium carbide industry near Fort William.

FOLLOWING an informal conference between representatives of the Sheffield and District Engineering Trades Employers' Association and of the Iron and Steel Trades Confederation, arrangements have been agreed to for holidays with pay, or holiday allowances, in steel-melting departments, including Siemens open-hearth and electric-furnace departments, in Sheffield. Points of detail are to be dealt with at a later stage. There are to be other conferences covering press shops and forges, and rolling mills, etc., at which other unions will be represented in addition to the Iron and Steel Trades Confederation.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

G. A. Mitchell, Limited, 9, Jubilee Road, Leicester.—Capital, £5,000. Iron and brass founders, etc. Directors: G. A. Mitchell and S. Mitchell.

Lloyds Perran Iron Company, Limited, Shell-Mex House, Victoria Embankment, London, W.C.2.—Capital, £100. Directors: S. C. E. Lloyd and Mrs. E. N. Tozer.

Richard W. Carr & Company, Limited, Pluto Works, Penistone Road, Sheffield.—Capital, £10,000. Steel and tool manufacturers. Directors: S. J. and H. S. Walker, A. Liller, R. H. G. and G. J. Carr.

Contract Open

Belfast, November 29.—Iron castings; malleable iron and steel; bolts and nuts, for the Harbour Commissioners. Mr. M. J. Watkins, general manager, Harbour Office, Belfast.

Personal

SIR WILLIAM FIRTH has been re-elected chairman of the Welsh Plate and Sheet Manufacturers' Association.

LIEUT.-COL. SIR GEOFFREY BYASS, the new Mayor of Port Talbot and Aberavon, is manager of the Mansel tinplate works.

DR. A. A. FORDHAM, of Swansea, was installed as chairman of the South Wales and Monmouthshire branch of the Institution of Structural Engineers at the branch's first meeting of the session at Cardiff recently. He succeeds Prof. W. Norman Thomas, of Cardiff.

MR. P. B. LIVERSIDGE, a managing director of the British Oxygen Company, Limited, retired from the board on November 2. Mr. W. W. Watt has been elected to fill the vacancy on the board to take effect on January 1, 1938, and has been appointed a managing director from that date.

MR. A. F. WEBBER, who for a number of years has been attached to the technical staff of the British Iron and Steel Federation, has resigned in order to take up an appointment as technical assistant to the managing director of the Superheater Company, Limited. Mr. Webber is well known in the iron and steel industry, having contributed important Papers to the Iron and Steel Institute, the Institute of Fuel, and other scientific bodies.

DR. J. W. MELLOR, F.R.S., who recently retired from the post of Director of Research of the British Refractories Research Association, has received a cheque for £1,500 and a gift of books, from the members of the Association, to mark their appreciation of his valuable work for the ceramic industries in general and the refractories branch in particular. Dr. Mellor has not been well enough to attend any public functions, and the presentation was made at his residence at Putney, London.

MR. GEORGE HEGGIE, a native of Falkirk, who has been Superintendent of Shops at Stevens Institute of Technology, Hoboken, New Jersey, since 1920, has retired. He served his apprenticeship as a patternmaker at the Carron Company's works, and went to America in 1907, becoming head foreman of the foundry of Ledgewood Company, Newark. Two years later he was appointed instructor in woodworking at Stevens Institute, and subsequently became Superintendent of Shops.

Obituary

MR. HAROLD BROADBENT, a director of Kitchen & Wade, Limited, machine tool makers, Halifax, has died, aged 47.

MR. JAMES NEIL, managing director of J. & J. Neil (Temple), Limited, engineers and ironfounders, of Glasgow, died last week.

MR. HENRY DAVISON, head of the firm of Davison & Company, Hexham Ironworks, Hexham, Northumberland, died suddenly on Tuesday, November 9.

MR. ATHOL JOHN CAPRON, a well-known figure in the Sheffield steel trade, died on November 7. He went to Sheffield in 1899 as manager of Davy Bros., Limited, Park Iron Works, and the following year became managing director. He relinquished that position in July, 1931, but remained a director. He was also a director of Newton Chambers & Company, Limited, Thorncliffe.

German Metal Resources

The problem of increasing the home production of the metals used in industry is being considered in Germany at the present time. The requirements of titanium, vanadium and molybdenum cannot be covered, but cobalt production can be increased to meet the whole of the requirements. Nickel production from the mines in the Palatinate, which were opened in 1935, might be increased from 125 tons to 375 tons per annum, while new mines are also being opened in Silesia, but their potential output is small. Although nickel imports from Greece have been increased, there will always be a need for Canadian nickel. In the case of beryllium, the problem is less serious, and a very considerable increase in production is expected, especially as its use in copper alloys is increasing. Production has been increased tenfold since 1934, and may go much higher.

Company Reports

Richard Thomas & Company, Limited.—Interim dividend of 5 per cent. on the ordinary shares.

Guest, Keen & Nettlefolds, Limited.—Interim dividend on the ordinary stock of 3 per cent. free of tax.

Turner & Newall, Limited.—Dividend on the 7 per cent. preference stock for half-year to September 30.

Brown, Bayley's Steelworks, Limited. — Dividend of 10 per cent., tax free, on the ordinary shares for the year ended July 31.

Leeds Fireclay Company, Limited.—Gross receipts to June 30, £136,495; repairs and maintenance of works and depreciation, £30,902; net profit, £46,787; brought in, £10,644; dividend of 6 per cent. on the preference shares, £30,000; dividend of 4 per cent. on the ordinary shares, £4,000; carried forward, £23,431.

Crabtree Electrical Industries, Limited.—Net profit for period from November 21, 1936, when the company was incorporated, to October 31, 1937, of £139,453, after writing off the expenditure during the year on plant, machinery, patents, etc. (£10,079), providing for depreciation on land and buildings, and making a provision of £49,530 for income-tax and N.D.C.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

470,379. CORHART REFRACTORIES COMPANY. Cores for moulds in which refractory materials are cast.

470,574. AKT.-GES. DER EISEN- UND STAHLWERKE VORM. G. FISCHER. Pipe fittings.

470,682. RENAULT, L. Furnaces for heat treatment in a gaseous atmosphere.

470,701. TRIGGS, W. W. (American Gas Furnace Company). Process and apparatus for case-hardening articles of iron, steel, or alloys thereof.

470,766. WAKELIN, A. J. Casting of metals and alloys.

471,564. SHEEPBRIDGE STOKES CENTRIFUGAL CASTINGS COMPANY, LIMITED, and STOKES, F. W. Manufacture of cylinder liners.

471,565. SHEEPBRIDGE STOKES CENTRIFUGAL CASTINGS COMPANY, LIMITED, and STOKES, F. W. Manufacture of piston rings.

471,862. LE TALL, F. W. (Vereinigte Edelstahl Akt.-Ges.). Method of manufacturing hard metal alloys.

Forthcoming Events

NOVEMBER 23.

Sheffield Society of Engineers and Metallurgists:—Discussion of selected Papers read at the Autumn Meeting of the Iron and Steel Institute, at Mappin Hall Department of Applied Science, Sheffield, at 7.30 p.m.

NOVEMBER 24.

Institute of Metals (London Section):—Supper dance, at Thames House, Millbank, London, S.W.1, at 7.30 p.m.

Institution of Mechanical Engineers (Yorkshire Branch):—"Training of Personnel for Industry." Paper by A. P. M. Fleming, C.B.E., at University, Sheffield, at 7.30 p.m.

Institute of Welding (Manchester Branch):—"Electrodes—Their Development and Uses." Paper by J. H. Paterson, at Manchester College of Technology, at 7.30 p.m.

NOVEMBER 25.

Institute of Welding (Leeds Branch):—"Electric Welding." Paper by E. C. Davies, at Griffin Hotel, Leeds, at 7.30 p.m.

Institute of British Foundrymen

NOVEMBER 27

Newcastle Branch:—Paper by E. B. Ellis and G. Elston, at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

The Institute of Vitreous Enamellers

NOVEMBER 25.

Scottish Section:—Paper by W. M. A. Shaw, at Royal Technical College Society's Rooms, Glasgow, at 7.30 p.m.

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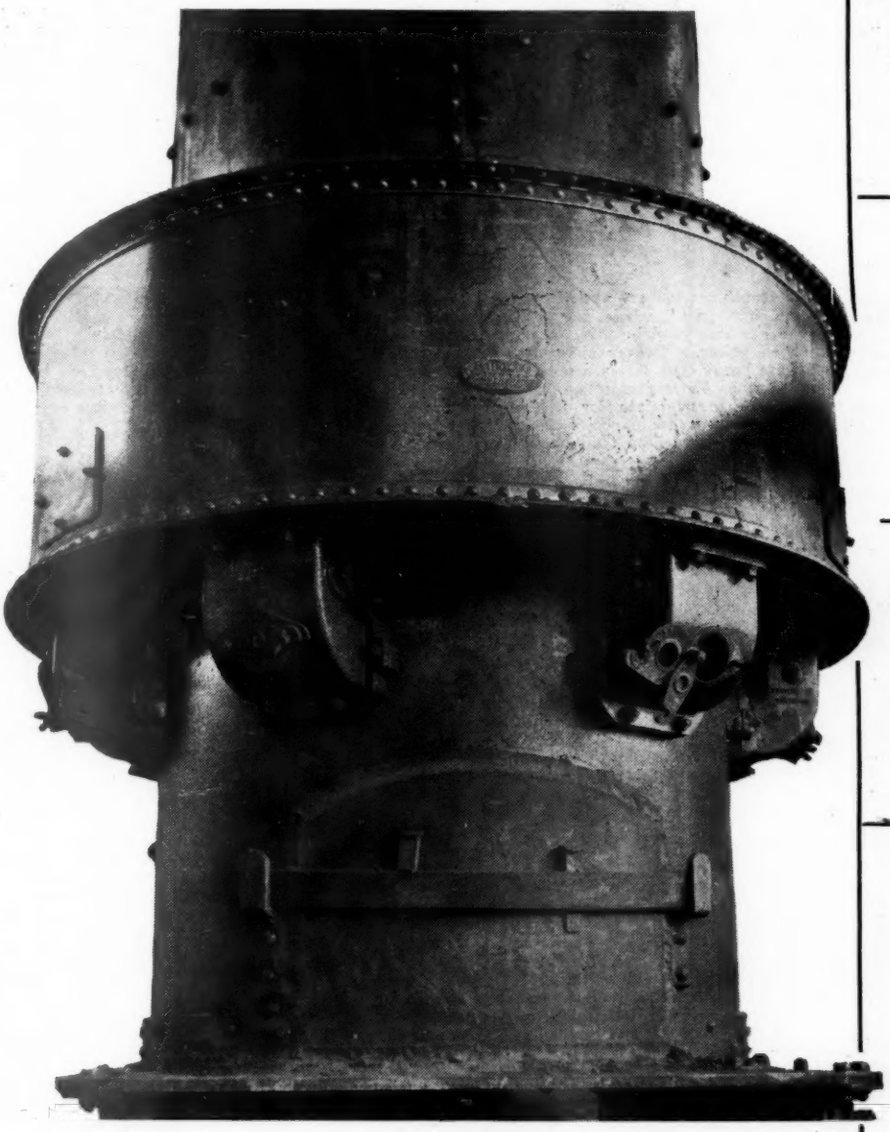

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MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place. Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

Consumers have welcomed the stabilisation of steel prices over the whole of next year. Business in foundry pig-iron and hematite is, meanwhile, held up by the absence of information regarding prices for 1938. There continues to be much speculation as to the amount, if any increase is to be made in pig-iron prices. Orders are certain to be forthcoming for substantial tonnages as soon as quotations are fixed.

Pig-Iron

MIDDLESBROUGH.—Although pig-iron deliveries are on an improved scale, contract arrears remain quite substantial, and even if prices were available for further business, makers would have to exercise caution. No doubt a good deal of business will go through when the new price list is announced, however, and it is hoped that the delay will be as short as possible. No. 3 Cleveland G.M.B. is quoted at 106s. per ton in the Middlesbrough area, less 5s. for consumers in the loyalty rebate scheme. New business in hematite also is suspended until it is known what the revised quotations will be. For deliveries up to the end of the year, East Coast mixed numbers are quoted at 122s. 6d. on the North-East Coast, less 5s. per ton rebate.

LANCASHIRE.—Consumers' pig-iron requirements have been well met recently, largely as a result of reduced needs of light-castings founders. Other concerns continue to be very active. For delivery to users in the Lancashire price zone, Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron are quoted at 114s. per ton, with Northamptonshire at 112s. 6d. and Derbyshire forge iron at 109s. to 111s., according to the class of consumer. A rebate of 5s. is in operation under certain conditions. West Coast hematite is quoted at 131s., and East Coast at 130s. 6d. There is a little Scottish foundry iron on offer at about 140s.

MIDLANDS.—Furnaces in this area are able to despatch good deliveries against contracts, and the position in this respect is quite satisfactory. Consumers are awaiting the publication of next year's prices. For delivery to Birmingham and district up to the end of the year, Northamptonshire No. 3 is quoted at 108s. 6d., with Derbyshire, Lincolnshire and North Staffordshire at 111s. Special irons are still in good request, and some business has been transacted for delivery over the first few months of 1938. Most users, however, would rather be certain of a fixed price basis. Ordinary grades of hematite are fairly plentiful, but users of special descriptions are not receiving full contract supplies. East Coast No. 3 is quoted at £6 13s. 6d., with West Coast at £6 14s. 6d., delivered in this area. An extra 1s. 6d. per ton is charged if delivery into works is required.

SCOTLAND.—While the rebate scheme has generally been well received, consumers in this area point out that they were just beginning to enjoy the arrival of good deliveries, and as this has been possible only through the utilisation of foreign iron, it is feared that supplies will again become scarce. Continental iron is available at moderate prices, but consumers are not taking further tonnages. No. 3 Scottish foundry iron is still quoted at 118s. f.o.t. furnaces, with No. 1 at 120s. 6d. There is no abatement of activity among steelmakers, and outputs remain at high levels. Quotations for steel-making irons are 123s. for mixed numbers of hematite, 107s. 6d. for Scottish basic, and 100s. for English and Indian basic, all less 5s. rebate, delivered steelworks.

Coke

The demand for all grades on the foundry-coke market is maintained and business is generally for fairly early deliveries. Failure to secure stabilisation of the price of coke is reported to be the result of a meeting between representatives of the South Yorkshire Coke Producers' Federation and ironmasters of the Midlands. It is stated that the iron masters were unable to accept the terms placed before them by the coke producers. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at 55s. 9d., with Welsh descriptions at from 55s. to 65s., according to quality.

Steel

The steel market has had a more settled appearance since the announcement of the decision of the steelmakers to maintain their prices unchanged for the whole of 1938, says the official report of the London Iron and Steel Exchange. A considerable volume of inquiry has been circulated and a certain amount of new business has been transacted for forward delivery. Most of the steelworks, however, are so fully provided with orders that they are not anxious to add to their commitments for the time being. The demand for semi-finished steel is still greater than can be met by the producers in this country, even when their output is supplemented by considerable imports. The tendency, however, for the home production of this class of material to expand, combined with increased deliveries of Continental semis, has made the general position somewhat easier. Conditions in the finished steel section of the market remain tight, and the makers appear to be concentrating more upon working off their orders than upon seeking new business, although a number of transactions for far forward delivery has been reported. The export demand continues quiet, but the steelmakers have important arrears to overtake in this department and shipments are on a good scale.

Scrap

There continues to be a scarcity of certain grades of scrap, but, on the whole, the position is inclined to be easier and good business is going through at controlled prices. The requirements of the steelworks are heavy, but stocks are held in some cases, although when the opportunity occurs consumers do not hesitate to negotiate for additional tonnages. In some instances ironfoundries are so well stocked that deliveries have been temporarily suspended.

Metals

Conditions on the non-ferrous metal market have shown a pronounced improvement during the past week. Business has involved heavier tonnages, and the outlook is better than it has been for a long time past. As yet, though, the tin market does not appear to have shared in the general improvement.

Copper.—The publication of the October copper statistics reveals that stocks were slightly higher than had been expected. World stocks of refined copper in October totalled 382,000 tons, compared with 344,738 tons in September. The apparent world consumption was 159,000 tons, against 184,000 tons. The world output by mines and smelters totalled 197,000 tons, against 197,000 also in September. The figures generally are considered to be quite satisfactory.

The market has borne a more settled appearance during the past week, and the outlook is definitely improving. Consumers have been buying larger tonnages, and industrial requirements are likely further to expand in the near future. The American market remains dull; the copper statistics were not viewed so favourably in New York, and sales were negligible following publication of the figures. The price remains at 11 cents.

Canadian copper production in August reached a new high record of 44,583,629 lbs. For the first eight months of the current year production rose by 22.4 per cent. to 329,899,425 lbs.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £41 3s. 9d. to £41 5s.; Friday, £41 to £41 2s. 6d.; Monday, £41 7s. 6d. to £41 10s.; Tuesday, £39 6s. 3d. to £39 7s. 6d.; Wednesday, £39 7s. 6d. to £39 8s. 9d.

Three Months.—Thursday, £41 10s. to £41 11s. 3d.; Friday, £41 5s. to £41 7s. 6d.; Monday, £41 13s. 9d. to £41 15s.; Tuesday, £39 12s. 6d. to £39 13s. 9d.; Wednesday, £39 12s. 6d. to £39 13s. 9d.

Tin.—Speakers at tin producing company meetings continue to take the opportunity to criticise the tin restriction scheme. Mr. C. V. Thomas, chairman of Ayer Hitam Tin Dredging Company protested at what he described as the inequitable ratios as between the signatories and the unfair voting powers given to the various parties under the scheme, and said that the scheme was too one-sided. The proposal to reduce the quota to 85 per cent. meant, in practice, that almost the whole cut must be borne by Malaya. If it were otherwise there would be no occasion to propose such a drastic cut as 25 per cent. The position would then be that Malayan producers would be working to a domestic quota of 62 per cent. approximately. In other words, they were being asked to restrict to 62 per cent. of assessment while some of their partners would still be able to work at a quota of over 100 per cent. and the rest at round about that figure.

It has been suggested recently that efforts were being made to summon a further special meeting of the International Tin Committee, as it was considered that the decision of the Committee that the quota would probably be reduced to 85 per cent. at the beginning of next year should be reconsidered at an early date. The Committee, it will be recalled, agreed to postpone a definite decision until December 10. Amsterdam is of opinion that no extraordinary meeting has been called; nor is any expected in Dutch circles. It is considered unlikely that further discussions after last month's meeting would give any substantial result.

There is little change to report in market conditions; prices have continued to fluctuate and new business is very quiet.

Official quotations were as follow:—

Cash.—Thursday, £204 15s. to £205; Friday, £198 10s. to £199; Monday, £197 to £197 10s.; Tuesday, £187 15s. to £188; Wednesday, £188 to £188 10s.

Three Months.—Thursday, £204 to £204 5s.; Friday, £197 10s. to £198; Monday, £196 10s. to £196 15s.; Tuesday, £187 to £187 10s.; Wednesday, £187 15s. to £188 5s.

Spelter.—Rather more cheerful conditions appear to have set in on this market. Buying has been heavier and continued improvement is now to be expected. Consumption is reported to be well maintained. A moderate business has been transacted on the Continent, but the tone is definitely firmer.

Daily market prices:—

Ordinary.—Thursday, £16 17s. 6d.; Friday, £16 13s. 9d.; Monday, £16 12s. 6d.; Tuesday, £16 2s. 6d.; Wednesday, £16 2s. 6d.

Lead.—Consuming trades have entered the market on a better scale recently, and quite good tonnages are changing hands. Still further improvement is anticipated. United States business remains quiet. Doubts concerning the maintenance of activity in the building trade are dispelled in the report of the Building Industries National Council. The industrial survey published by the Council states that the housing figures are very encouraging. There is no reason to believe that the pessimistic forecasts put forward in certain quarters of a marked decline in housing in the near future will be borne out, since, as the Chancellor of the Exchequer has pointed out, there is a great deal of housing work still to be done. Industrial and commercial building continues actively, and the contracting sections of the industry are very busy. The policy advocated by the Council that plans should be prepared for new works to be released as rearmament activity slackens is receiving increasing support. Figures published by the Board of Trade show that the downward movement in the wholesale price of building materials which began in July is continuing. For July the index figure was 105.7, for August 105.6, for September 105.5, and for October 105.3. The Ministry of Labour figures for September show that in that month the estimated cost of buildings for which plans were approved, submitted by 143 authorities, was £9,093,800, compared with £9,018,300 for the corresponding month of last year.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £17 12s. 6d.; Friday, £17 12s. 6d.; Monday, £17 13s. 9d.; Tuesday, £17 6s. 3d.; Wednesday, £17 6s. 3d.

Scrap.—Despite the improvement in the non-ferrous metal markets, there is little change to report with regard to scrap. Business remains dull and uninteresting.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £40; foil, £94 to £98. Copper, £38 to £42; braziery, £36. Brass (clean), £27 to £29. Zinc, £10. Lead, £15 10s. Gunmetal, £39 to £40.

THE 30TH FOIRE DE PARIS is to be held at the Parc des Expositions, Porte de Versailles, from May 21 to June 6, 1938.

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RAW MATERIALS—PRICE LIST

(Wednesday, November 17, 1937)

COPPER

	£	s.	d.
Standard cash	39	7	6
Three months	39	12	6
Electrolytic	44	0	0
Tough	44	5	0
Best selected	44	15	0
Sheets	78	0	0
India	55	10	0
Wire bars	46	0	0
Ingot bars	46	0	0
H.C. Wire rods	49	10	0
Off. av. cash, Oct.	45	8	9
Do., 3 mths., Oct.	45	12	11
Do., Sttlmnt., Oct.	45	8	9½
Do., Electro, Oct.	51	9	9½
Do., B.S., Oct.	51	17	6
Do., Wire bars, Oct.	52	7	1½
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8½d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	9½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	8½d.
Yellow metal rods	6½d.

TIN

	£	s.	d.
Standard cash	188	0	0
Three months	187	15	0
English	188	0	0
Bars	189	15	0
Straits	191	5	0
Eastern	184	12	6
Banca (nom.)	—		
Off. av. cash, Oct.	224	0	11⅞
Do., 3 mths., Oct.	223	9	10½
Do., Sttlmt., Oct.	224	1	10½

SPELTER

	£	s.	d.
Ordinary	16	2	6
Remelted	14	0	0
Hard	13	10	0
Electro, 99.9	19	15	0
English	17	7	6
India	15	15	0
Zinc dust	24	0	0
Zinc ashes	6	5	0
Off. aver., Oct.	17	16	9¼
Aver., spot, Oct.	17	14	5 3/16

LEAD

	£	s.	d.
Soft foreign, ppt.	17	6	3
Empire (nom.)	18	2	6
English	19	10	0
Off. aver., Oct.	18	5	9⅜
Aver. spot, Oct.	18	5	2½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	30 0	0 to 30	10 0
Do., V.M. ex-whse.	30 0	0 to 30	10 0
Rods		24	15 0

ANTIMONY

English	87 10	0 to 88	10 0
Chinese, ex-whse. (nom.)		72	0 0
Crude, c.i.f.		46	0 0

QUICKSILVER

Quicksilver	13 0 3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	14 10 0
45/50%	12 0 0
75%	17 0 0
Ferro-vanadium	
35/50%	12/8lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	9/3 lb.
Tungsten metal powder—	
98/99%	9/6 lb.
Ferro-chrome—	
2/4% car.	34 15 0
4/6% car.	24 5 0
6/8% car.	24 0 0
8/10% car.	24 0 0
Ferro-chrome—	
Max. 2% car.	36 0 0
Max. 1% car.	38 5 0
Max. 0.5% car.	41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales (West)—	£	s.	d.	£	s.	d.
Heavy steel, best	3	8	6	to 3	11	0
Mixed iron and steel	3	6	0	to 3	8	6
Heavy cast iron	3	8	6	to 3	11	0
Good machinery				3	17	6
Cleveland—						
Heavy steel, best	3	7	0	to 3	9	6
Steel turnings				2	15	0
Heavy cast iron				4	5	0
Heavy machinery				4	10	0
Midlands—						
Short heavy steel				4	0	0
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0	to 4	5	0
Steel turnings	2	5	6	to 2	8	0
Scotland—						
Heavy steel, best	3	5	0	to 3	7	6
Ordinary cast iron	4	7	6	to 4	10	0
Cast-iron borings	2	0	0	to 2	2	6
Wrot-iron piling				4	17	6
Heavy machinery	4	15	0	to 4	17	6

London—Merchants' buying prices, delivered yard.

Copper (clean)	33	0	0
Brass	23	0	0
Lead (less usual draft)	15	0	0
Tea lead	12	0	0
Zinc	10	0	0
New aluminium cuttings	71	0	0
Braziery copper	30	0	0
Gunmetal	33	0	0
Hollow pewter	135	0	0
Shaped black pewter	99	0	0

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	108/6
,, No. 3	106/-
,, No. 4	105/-
Forge No. 4	105/-
Hematite No. 1	123/-
Hematite M/Nos.	122/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-
,, d/d Birm.	134/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	108/-
,, No. 3 fdry.	111/-
Northants forge	105/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	108/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	123/-
Sheffield (d/d district)—	
Derby forge	105/6
,, fdry. No. 3	108/6
Lincs forge	105/6
,, fdry. No. 3	108/6
W.C. hematite	128/6
Lancashire (d/d eq. Man.)—	
Derby fdry, No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	140/-
Clyde, No. 3	140/-
Monkland, No. 3	140/-
Summerlee, No. 3	140/-
Eglinton, No. 3	140/-
Gartsherrie, No. 3	140/-
Shotts, No. 3	140/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0	to 13	15	0
Nut and bolt iron	11	12	6	to 12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0	to 11	10	6
Boiler plts.	11	18	0	to 12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ⅜ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	11½d.
Sheet to 10 w.g.	11½d.
Wire	13d.
Rods	13½d.
Tubes	18½d.
Castings	15½d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	38/6
,, furnace	37/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	22/9 to 23/9
,,	28×20	,,	45/6 to 47/6
,,	20×10	,,	33/6 to 34/-
,,	18¾×14	,,	23/6 to 24/-
C.W.	20×14	,,	21/- to 21/6
,,	28×20	,,	42/- to 43/-
,,	20×10	,,	31/6 to 32/-
,,	18¾×14	,,	22/6 to 23/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0	to £13	0	0
Bars-hammered, basis	£20	0	0	to £22	0	0
Bars and nail-rods, rolled, basis	£19	0	0	to £20	0	0
Blooms	£18	0	0	to £19	0	0
Keg steel	£30	0	0	to £35	0	0
Faggot steel	£20	0	0	to £25	0	0
Bars and rods dead soft st'l	£19	0	0	to £20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Nov. 11 ..	41	3	9	inc.	41/3
,, 12 ..	41	0	0	dec.	3/9
,, 15 ..	41	7	6	inc.	7/6
,, 16 ..	39	6	3	dec.	41.3
,, 17 ..	39	7	6	inc.	1/3

Electrolytic Copper

	£	s.	d.		
Nov. 11 ..	46	0	0	inc.	50/-
,, 12 ..	46	0	0	No change	
,, 15 ..	46	10	0	inc.	10/-
,, 16 ..	44	0	0	dec.	50/-
,, 17 ..	44	0	0	No change	

Standard Tin (cash)

	£	s.	d.		
Nov. 11 ..	204	15	0	inc.	250/-
,, 12 ..	198	10	0	dec.	125/-
,, 15 ..	197	0	0	,,	30/-
,, 16 ..	187	15	0	,,	185/-
,, 17 ..	188	0	0	inc.	5/-

Tin (English ingots)

	£	s.	d.		
Nov. 11 ..	204	15	0	inc.	250/-
,, 12 ..	198	10	0	dec.	125/-
,, 15 ..	197	0	0	,,	30/-
,, 16 ..	187	15	0	,,	185/-
,, 17 ..	188	0	0	inc.	5/-

Spelter (ordinary)

	£	s.	d.		
Nov. 11 ..	16	17	6	inc.	20/-
,, 12 ..	16	13	9	dec.	3/9
,, 15 ..	16	12	6	,,	1/3
,, 16 ..	16	2	6	,,	10/-
,, 17 ..	16	2	6	No change	

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Nov. 11 ..	20	10	0	inc.	20/-
,, 12 ..	20	6	3	dec.	3/9
,, 15 ..	20	5	0	,,	1/3
,, 16 ..	19	15	0	,,	10/-
,, 17 ..	19	15	0	No change	

Lead (soft foreign, prompt)

	£	s.	d.		
Nov. 11 ..	17	12	6	inc.	12/6
,, 12 ..	17	12	6	No change	
,, 15 ..	17	13	9	inc.	1/3
,, 16 ..	17	6	3	dec.	6/3
,, 17 ..	17	6	3	No change	

Lead (English)

	£	s.	d.		
Nov. 11 ..	19	15	0	inc.	15/-
,, 12 ..	19	15	0	No change	
,, 15 ..	19	15	0	,,	,,
,, 16 ..	19	10	0	dec.	5/-
,, 17 ..	19	10	0	No change	

Imports and Exports of Pig-iron, Castings, etc., in October and the Ten Months 1937, compared with October and the Ten Months 1936

	October.		Ten months.		October.		Ten months.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	11,777	24,033	106,110	171,583	37,076	127,669	333,520	710,520
,, ,, Other British Countries	—	—	—	42,609	—	—	—	233,672
,, ,, Foreign Countries	11,696	38,388	90,070	286,893	40,911	241,299	310,427	1,757,001
Total	23,473	62,421	196,180	501,085	77,987	368,968	643,947	2,701,193
Castings and forgings	467	546	5,771	2,684	15,608	15,811	201,081	84,150
Cast pipes and fittings	133	391	1,286	1,673	3,892	9,307	42,055	41,034
Stoves, grates, etc.	63	83	648	792	4,135	6,622	60,092	74,128
Baths	952	545	6,785	7,585	22,333	14,504	164,902	187,496
Hollow-ware, all kinds	290	395	3,022	3,375	16,180	25,203	162,367	203,363
Exports.								
Pig-iron, forge and foundry	3,541	4,497	47,359	77,211	16,414	28,080	183,024	414,287
,, acid	5,583	5,502	35,815	53,863	21,632	36,084	131,359	301,408
,, basic	4	—	152	668	17	—	810	4,591
Total	9,128	9,999	83,326	131,742	38,063	64,164	315,193	720,286
Castings and forgings	275	172	3,323	2,564	10,164	7,416	125,159	98,707
Cast pipes and fittings, up to 6 in. diameter	5,027	5,271	47,602	50,587	58,201	64,528	533,702	573,031
,, ,, ,, over 6 in. ,,	3,372	4,949	32,401	42,057	28,225	47,688	265,407	340,794
Stoves, grates, etc.	1,116	808	8,689	9,218	53,326	45,060	437,798	492,437
Sanitary cisterns	280	342	2,515	3,004	8,271	11,647	77,591	101,531
Bedsteads, including tubes therefor	522	475	4,142	4,912	18,499	19,878	152,082	194,455
Hollow-ware	564	398	4,587	4,410	19,218	15,867	165,443	158,869

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRY Manager desires similar position; broad experience in general engineering, machine tool, alloy pressure castings and non-ferrous, mechanised plant; pattern shop, sound rate fixer and organiser.—Box 674, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATTERNMAKER, keen, age 26, experienced in high-class aero work, seeks a progressive and more responsible position. Any district. Further particulars willingly. Write H. BUSBY, 49, Woodmarket, Lutterworth, Rugby.

LARGE Manufacturers of Light Castings for Porcelain Enamelling require young technically-trained Executive with foundry pattern-shop and drawing office experience. Excellent opportunity. Replies treated in strict confidence to: Box 678, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

RESEARCH ASSISTANTS required by the British Cast Iron Research Association, preferably graduates in metallurgy, chemistry or physics. Work on vitreous-enamelled cast iron and alloy cast iron. Works experience a recommendation. Applications to, and further details from, DIRECTOR, 21, St. Paul's Square, Birmingham.

SECRETARIAL ASSISTANT.—The Institute of British Foundrymen invites applications for position of Technical and General Assistant to Secretary. Engineering or metallurgical technical experience essential. State experience, age, salary expected, to SECRETARY, St. John Street Chambers, Deansgate, Manchester, 3, marking envelope "Assistant."

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Foreman desires similar position or as Foundry Manager. Ten years' experience as under-foreman, foreman and head foreman. Textile, mill gearing and general engineering experience in green sand, dry sand and loam. Wide experience, machine moulding and repetition work. (312)

THOROUGHLY practical Foundry Foreman requires situation. Experience on high-class machine tool work, and jobbing castings, chemical pots, etc. Moulding and repetition experience, also loam moulding. (313)

METALLURGICAL Chemist with experience as chief chemist seeks re-appointment. Age 26. Eight years' uninterrupted experience in analysis of all foundry products and materials. Ferrous metallurgy at Sheffield University. Finest credentials. (314)

BUSINESS FOR SALE

£950.—Engineering Machine Shop and small Ferrous and Non-ferrous Foundry Plant in working condition. 2,400 sq. ft. under roof. Reasonable rent.—Write only: ENGINEER, 8, Colson Road, Croydon.

PROPERTY

MODERN Steelfoundry at Rotherham, main building 65 ft. by 150 ft. (erected 1916); complete with 10-ton crane. Site 1 acre. Siding on L.N.E. Rly. Adjacent canal.—Apply: GORDON, P.O. Box 98, Sheffield.

MACHINERY

FOR SALE.—Guttmann 9-ft. dia. Table Sandblasting Plant, four nozzles; also several Hand and Pneumatic Moulding Machines; 1½-2-ton Cupola; 10-cwt. and 15-cwt. Cupolettes.—Box 670, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SMALL Power Machine for cutting gits off bronze castings. Write for particulars.—TRIONITE, LTD., Cliffe Vale, Stoke-on-Trent.

NEW Dwarf Cupola, to melt 10 to 15 cwts per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

'Phone **98** Staines.

TILGHMAN Air Compressor, 130 c.f. at 100 lbs.
25-h.p. Marshall Horizontal Crude-Oil Engine.
Air Receiver, 19 ft. 6 in. by 3 ft., 100 lbs.
Vertical Boiler, 9 ft. 6 in. by 4 ft., 80 lbs. w.p.
3-ft. Sand Mill, underdriven.
HARRY H. GARDAM & CO., LTD., STAINES.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
ELECTRIC MOTORS: Large stock to suit almost all electric systems.
S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.
MOULDING MACHINES.

Pneu. 12" cyl. (Jackman) Plain Jolt Ram, table 5' square; weight 50 cwts.
No. 7 Ajax Jolt Turn Over and Pattern Drawer, 7" dia. cyls., lifting cap. approx. 8 cwts., height of jar 1¼"; air consumption approx. 22 cub. ft. per min.
Write for "Albion" Catalogue.
'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & Co., LTD., Station Works, Ecclesfield, Sheffield.

MISCELLANEOUS

WAX CORE VENTS in 1-lb. rolls; all sizes from 1/16 in. dia. Best and cheapest. Quick despatch.—WILLIAM OLSEN, LTD., Hull.

QUEBEC YELLOW PINE.—H. R. Hodgson & Co., Importers, 94, Derby Road, Bootle, Liverpool.

PATTERNS.—Cleghorn & Co. have new premises at 198-200, Bath Road, Worcester, and are in a better position to cope with all classes of engineers' pattern. 'Phone 264.

FINEST FOUNDRY BLACKINGS AND FACINGS. Pure Ceylon Plumbago (Import direct), Finest Core Gum, White Dust, Parting Powder (Silica free), Pure Ground Carbon and Electrodes. Quality at reasonable prices. Orders repeated. Send for free sample.
JOHN & C. DURRANS,
PENNINE WORKS,
HAZLEHEAD, NEAR SHEFFIELD.
Telephone: 128 Penistone. Telegrams: "Facings, Penistone."

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—FURMSTON & LAWLOR, Letchworth.

'Phone: 287 SLOUGH

Nearly new 600-lbs. capacity oil-fired Morgan Tilting Furnace Price, £80

1,000-lbs. capacity gas-fired semi-rotary IONIDES Melting Furnace; new condition.....Price, £65

500-lbs. capacity Armstrong-Whitworth Rotary Oil-fired Furnace, complete as new. Price, £50

Oil-Sand Mixer, large size, as new Price, £24

Utard jolt squeeze moulding machine 24" square ..... Price, £48

One Sand Grab and two Sand Valves complete with hoppers for placing above moulding machines. Cheap

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!

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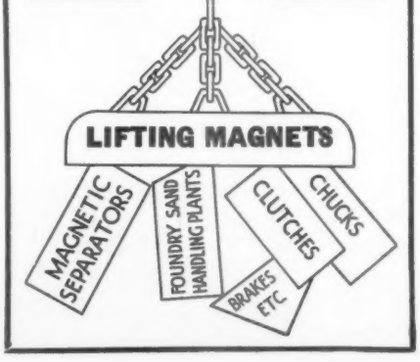
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